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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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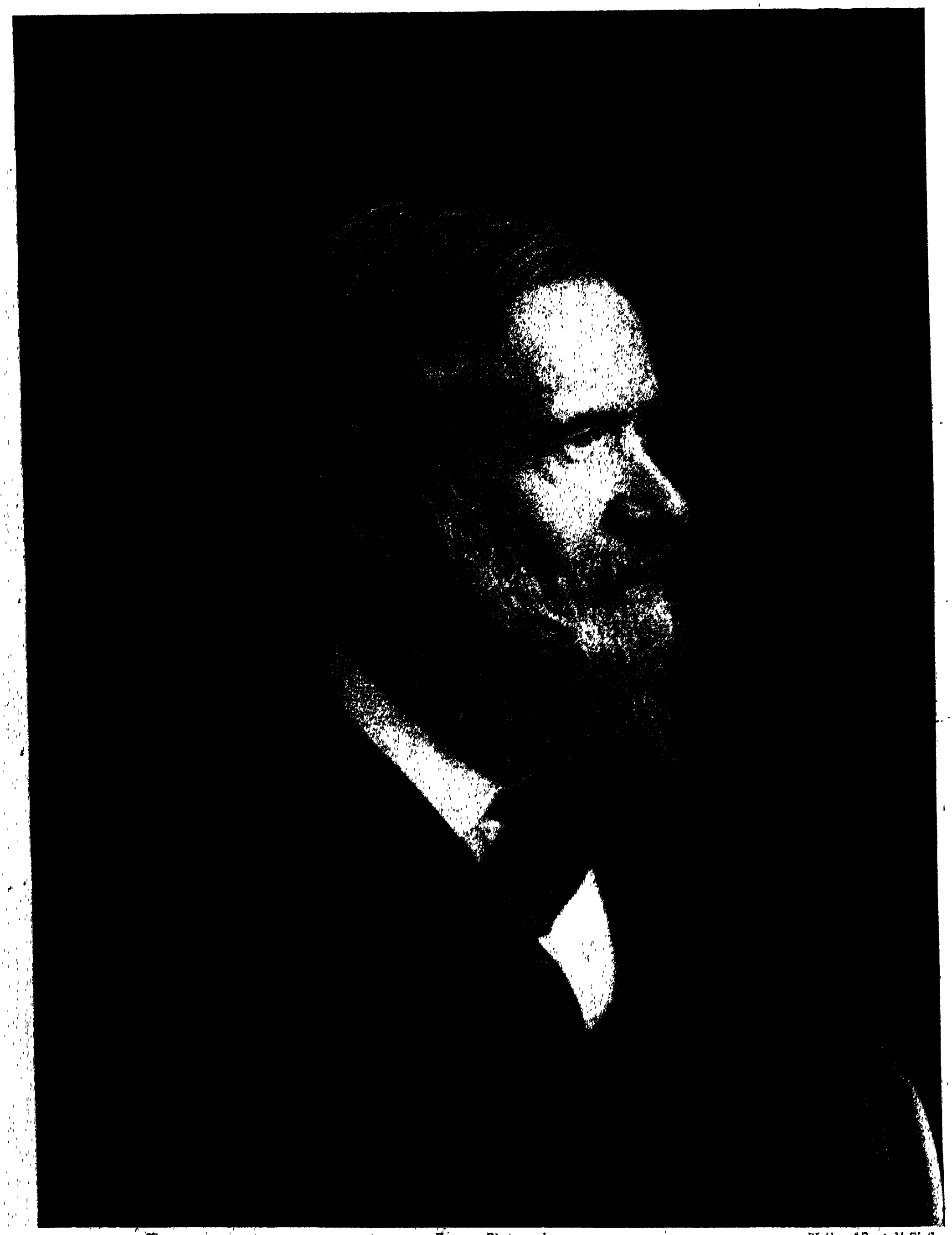

From a Photograph

Walker & Boutall, Ph. Sc.

Stanislao Cannizzaro

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, MAY 6, 1897.

SCIENTIFIC WORTHIES.

XXX.—STANISLAO CANNIZZARO.

IN the autumn of last year there occurred in Rome an event which attracted the attention of the whole scientific world, and more especially of that portion of it which is concerned with chemistry. The occasion was the celebration of the seventieth anniversary of the birth of Prof. Stanislao Cannizzaro, Senator of the Kingdom of Italy, and Professor of Chemistry in the University of Rome. The pages of this journal have already borne witness to the feelings of esteem and gratitude which that event evoked. At the public meeting called to do him honour, all the learned bodies in the world which have any concern with science, or have any regard for its welfare, combined to offer their felicitations, and vied with each in the warmth of their expressions of appreciation and good will, and a multitude of letters and telegrams were received from chemists in all parts of Europe and America. The place of honour in the list of the addresses, as enumerated in the interesting account of the ceremony since published, is given to that from the Royal Society, which repeated the terms in which the Council had previously made known to Prof. Cannizzaro its reason for awarding him the highest distinction in its power. Next comes that from the Chemical Society, which recalls with pride that the name of Cannizzaro has given lustre to the roll of its foreign members for more than half the period of his life-time.

In what follows we desire to give an account of the life and labours of one whom men of all nations have thus shown themselves eager to honour.

Stanislao Cannizzaro, the fourth and youngest son of Mariano Cannizzaro and Anna Dibenedetto, was born on July 13, 1826, at Palermo, where his father was a magistrate, Director-General of the Sicilian Police, and subsequently President of the High Court of Chancery. The future chemist was educated partly at home and partly at the normal school of his native city, and on the death of his father in 1836, he was placed in the Carolino Calasanzio College. The cholera epidemic of 1837 ravaged Palermo, the young Cannizzaro lost two of his brothers, he himself was attacked by the terrible scourge, and it was only after a tedious convalescence that he was able to resume his studies. Elementary education in Sicily at that time was wholly under the control and direction of the priests: grammar, rhetoric, poetry and philosophy, with a very small modicum of mathematics and geography, constituted the pabulum on which the youth of the period was fed. The physical sciences, of course, had no place in a system which was essentially mediæval. The boy soon gave evidence of his power, and after a school career of distinction he entered, in 1841, the University of Palermo with the intention of devoting himself to medicine.

The subject, however, proved uncongenial, and the youth tried in vain to pass the necessary examinations. Stimulated, however, by Foderà, who at that time taught physiology in Palermo, and with whom the young student became intimately acquainted, he was led to take up experimental work in connection with chemical physiology. It is needless to say that at this period Palermo possessed no laboratory accommodation, and all the manipulative essays that the young experimentalist could venture upon had to be done at his home, and with such improvised appliances as he could command. In the autumn of 1845 he went to Naples, where he came in contact with Melloni, the most eminent Italian physicist of his time, with whom he contracted a warm friendship. Mainly through the recommendation of Melloni, who quickly learned to appreciate the character and power of his young friend, Piria, who is honourably known to chemists by his researches on plant products, was led to offer the young Sicilian the post of *préparateur* in the chemical laboratory of the University of Pisa. To Pisa accordingly he went, and the step decided his career. What Melloni was to physics in Italy at that period, Piria was to chemistry. The young assistant could have had no better master. Raffaele Piria, then in the full tide of his vigour, was an admirable, albeit a most exacting teacher. A distinguished pupil of Dumas, and a remarkable expositor, his lectures were distinguished by the same love of method, of orderly arrangement, of

precision, neatness, and even elegance that characterised his laboratory work; and Cannizzaro and his fellow-assistant Bertagnini must at times have been sorely exercised to satisfy the rigorous ideal of exactitude and of manipulative skill required by the Professor in the experimental illustration of his lectures. When not employed in the class-room, his duty was to wait on Piria in the laboratory. Piria during that period was engaged upon those inquiries on salicin, populin, asparagin, and their derivatives, by which he is best known to the chemists of this time. The greater part of the experimental labour connected with these investigations was done by Piria himself during the eight hours that he daily spent in his laboratory, Cannizzaro being for the most part, as he says, a simple looker-on, observing attentively and in silence the rare skill and manipulative ability with which the work was executed. Occasionally, however, the assistant would be called upon to continue some experiment or analysis which Piria had begun, or to prepare some material he needed; all of which he was required to perform in literal compliance with the instructions he received from the master. Most of the work of preparation in connection with the lectures had to be done in the early morning, before Piria descended from his apartments to the laboratory. These preparations were carefully scrutinised by the Professor, who would tolerate no slovenliness or negligence, and whose æsthetic sense demanded that the apparatus should not only work well but look well. Although a silent worker during the day-time, and a most severe judge of his assistant's duty whether in the laboratory or in the lecture-room, Piria could unbend in his hours of ease, and many an evening was spent by Cannizzaro with his master, who would then freely discuss chemical subjects with his young assistant, and explain the object and meaning of the work on which he had been engaged during the day.

This severe discipline, to which Cannizzaro frankly confesses he owes much of the success of his after-career as a chemist, was interrupted by events, which, as they have turned out, had no small share in determining also his success in his career as a politician. Returning to Sicily at the end of July 1847, presumably to spend his vacation at home, the ardent young Liberal of twenty-one, mindful of the events of 1836, naturally found himself in active sympathy with the movement of the time, and when the revolution broke out in January 1848, he became an officer of artillery at Messina. Having been elected deputy for Francavilla in the Sicilian Parliament, he went to Palermo at the end of March, and, as the youngest member of the Assembly, he was required to act as its Secretary. After the bombardment and fall of Messina on September 7, 1848, he was sent to Taormina to organise resistance to the advance of the royal troops. The armistice of September 13, extorted by the combined fleets of England and France to put a stop to the atrocities of Ferdinand's army, stayed for the moment further hostilities, but Cannizzaro was ordered to remain at his post as Commissioner of the provisional Government. The armistice ended in the following March, and after the disaster of Novara, and with it the abdication of Charles Albert, the Sicilian movement utterly collapsed. The royal troops were everywhere victorious, the insurgents retreated first to Catania and thence by Castrogiovanni to Palermo, and, in May 1849, Cannizzaro, with a number of his compatriots, succeeded in escaping for Marseilles on board the Sicilian frigate *Indipendente*. He was now in exile, and led for a while a somewhat wandering and aimless existence. After a short stay in Marseilles, he passed on to Arles, and visited in turn Avignon, Lyons, Nîmes and Montpellier. In time, however, he again betook himself to his chemical studies, although his means were very limited and his opportunities few. He had, of course, no laboratory, but he read such books as he could obtain, and visited such chemical factories as would admit him. When the body of the unfortunate and broken-hearted Charles Albert was brought back from Oporto, to be buried in the land for whose liberty he had sacrificed his kingship, Cannizzaro joined his fellow-refugees in Turin in order that they might testify by their presence at the obsequies of the dead monarch their grateful memory of his services, and their resolution that his tomb on the Superga should be to them the symbol of an undying aspiration.

Towards the end of October, Cannizzaro found himself in Paris. Thanks to a letter from Piria, he became acquainted with Cahours, who introduced him into the little laboratory of Chevreul attached to the theatre in the Jardin des Plantes, where he found Cloëz installed as assistant. He had now abundant opportunities for work, and with the characteristic ardour of his Southern blood he embraced them all. The excitement of political disquietude in Paris has never seemed to react disastrously on the progress of science there. Curiously enough, for some inscrutable reason, it would appear to stimulate it. Indeed, some of the darkest and most unsettled periods of the political history of France have been among the brightest and most glorious epochs in the annals of science. The stir of 1848, and the unrest which followed it, were contemporaneous with an extraordinary activity in chemical and physical inquiry in Paris, and Cannizzaro participated to the full in the busy movement going on around him. Dumas, it is true, had been swept by his political convictions into the Legislative Assembly, to become Minister of Agriculture and Commerce; and his laboratory in the Rue Cuvier, in spite of the seductive offer of Jecker, was closed.

Still, if Cannizzaro never came under the spell of Dumas, he could witness Fremy's experiments in the laboratory of Gay Lussac, and could attend Regnault's lectures in the Collège de France. But it was to the chemical work-table he mainly turned, and on this he spent the greater part of his time and energies. He took up the study of the amines, the existence of which had recently been made known by Wurtz, and, with Cloëz, prepared cyanamide by the action of ammonia on cyanogen chloride. An account of the nature and properties of this compound, published in 1851 in conjunction with Cloëz, constitutes Cannizzaro's first contribution to the literature of chemistry. The reaction by which they obtained the substance proved exceedingly fruitful, and, by the substitution of amines for ammonia, Cahours and Cloëz subsequently prepared the alkyl cyanamides. Moreover, cyanamide itself, by the ease with which it suffers polymerisation, gives rise to a number of isomeric

series of homologous amides of considerable theoretic interest. Congenial and inspiriting as the atmosphere of Paris might be, man cannot live on air alone. But there were too many young and eager aspirants, of French nationality, for the few posts which practically only Paris was able to offer, to justify the hope that the young Sicilian could obtain a position, sufficiently lucrative even for his modest requirements, in the land of his exile. Piedmont, of all the Italian States, could alone afford an asylum to him, and accordingly, towards the end of 1851, he accepted the position of Professor of Physical Chemistry and Mechanics in the National College of Alessandria, an institution modelled somewhat on the lines of a German Realschule. Here, thanks to the action of the municipality, he was provided with a small laboratory, together with an assistant, and, although much occupied by his public lectures on chemistry and mechanics given to the townspeople, in addition to his regular class instruction, he began the study of the action of alkylamines on cyanogen chloride, only to find himself forestalled by Cloëz and Cahours. At about the same time he discovered benzyl alcohol, which he obtained by the action of alcoholic potash on bitter almond oil, and the properties and modes of decomposition of which he described in a series of letters to Liebig and Wöhler, published in the *Annalen.* His vacations were usually spent with Piria at Pisa, or at Montignoso, near Massa-Carrara, with his old collaborateur Bertagnini, with whom he worked on anisic alcohol (*Ann. de Chimie*, xlvii. 285).

In October 1855, he was called to the chair of Chemistry at the University of Genoa, and at the same time Piria was moved from Pisa to Turin. Although the new position at Genoa was one of greater dignity and emolument, Cannizzaro found himself, so far as laboratory accommodation was concerned, less favourably situated than at Alessandria; the only place at his disposal was a damp and dimly-lighted room, without the slightest convenience for even the most elementary experiments. For some months he found it impossible to carry on the work he had begun at Alessandria. In the following year he obtained a room on the upper floor of the University building, and this, with the aid of an assistant and a couple of pupils, he turned into a fairly convenient laboratory, where he resumed his work on the aromatic alcohols. At Genoa Cannizzaro began the studies on chemical philosophy, which were to culminate in the great generalisation with which his name will continue to be associated. Admirable as his experimental labours are, his chief claim to the esteem and gratitude of his contemporaries and of posterity rests upon his critical contributions to the philosophy of chemistry. In what this signal service consisted will be shown subsequently.

During the whole of this time Italy was in a state of political ferment. The astute Cavour had gradually secured his ascendancy in the parliamentary Councils of the little Sardinian kingdom, and with it his position in the Councils of Europe. Slowly, and in spite of many checks, the cause of Italian unity gained ground. Magenta and Solferino secured Lombardy, and although Victor Emmanuel was forced to give up Savoy, the very cradle of his dynasty, as the price of Louis Napoleon's co-operation, Italy gained Tuscany, Modena, Parma and Romagna; and in 1860 the annexation of Central Italy was complete. Bombino still held his grip on the two Sicilies, but the islanders made one more effort to throw off the hateful yoke. The time seemed propitious, and Palermo, Messina and Catania were soon ablaze; and before the middle of May, Garibaldi and his famous "Mille" had accomplished the liberation of the island. Cannizzaro immediately returned to Palermo. He found here his aged mother and sisters, whom he had not seen since 1849, and at once threw himself into the labour of organising and consolidating the work of the revolution, taking an active part in the debates of the States Council convened to define the relation of Sicily to Italian unity. The affair of Spartivento to all intents and purposes decided the fate of Lower Italy, and by the first week of September Garibaldi was in Naples, and with the shutting up of the last and feeblest of the Neapolitan Bourbons in Gaeta, the emancipation of Italy was practically secured. What remained to be done time would effect.

Cannizzaro now returned to Genoa, passing through Naples, where Piria had been called to reorganise the system of public instruction, and resumed his work at the University. In the preceding March he had been offered, but had declined, the Professorship of Organic Chemistry in the University of Pisa. He was now invited to occupy the chair on the same subject in the University of Naples, and this he also refused. He was then claimed by his native town, and in October 1861, he was named Professor of Inorganic and Organic Chemistry, and Director of the Laboratory of the University of Palermo. What he had to "direct" was contained in a few cupboards, in the same class-room that he had sat in as a student in 1842, and was barely sufficient for even the most elementary illustrations. The whole of the following year was spent in organising his courses and in superintending the arrangement and plenishing of the rooms he ultimately acquired on the top-floor of the University building.

Cannizzaro remained at Palermo for about ten years; he took an active share in the management of the University, and for a time was its Rector. Its influence as a school of chemistry may be judged of from the fact that he had as co-workers Adolph Lieben, Wilhelm Koerner, and lastly Paterno, who has succeeded him in the chair. For the most part he occupied himself, as regards his laboratory work, with the study of aromatic compounds, and in extending and completing his researches on the amines.

If Cannizzaro was useful to the world as a chemist, he was so far mindful of Priestley's example as to strive to be equally useful to Palermo as a citizen, and much of his time and ability was freely given in the service of her municipal government, more particularly on subjects relating to elementary and secondary education.

In 1871 Cannizzaro was called to occupy his present position of Professor of Chemistry in the University of Rome, and Director of the Chemical Institute in the Orto di S. Lorenzo in Panisperma, and here, for the last five-and-twenty years, he has annually delivered his two courses, each of three lectures a week, on general and organic chemistry, and has worked out, partly alone and partly in conjunction with his pupils Amato, Blaserna, Carnelutti,

Sestini, Valente, Fabris and Andreocci, the chemistry of santonin. At the same time that he was called to Rome he was made a Senator of the kingdom, and as a moderate Liberal he has taken his share in the consolidation of the constitution of regenerated Italy.

Cannizzaro, when compared with such men as Berthelot and certain of the leaders of the German schools of chemistry, or even with some of the younger generation of Italian chemists, cannot be called a voluminous writer. In all about eighty memoirs have proceeded from his laboratory. It is on the special quality and character of his published work, rather than on its extent, or on the range and variety of its subject-matter, that his fame depends. In this respect he resembles the late August Kekulé. The names of both men will for ever be associated in the history of chemistry with the promulgation of generalisations which mark epochs in the development of chemical science. Cannizzaro's great merit consisted in being the first to clearly point out the bearing on chemical theory of the hypothesis which is commonly associated with the name of his countryman Avogadro, but which Cannizzaro himself, in his well-known lecture delivered before the Fellows of the Chemical Society in 1872, associated also with the names of Ampère, Krönig and Clausius. This, perhaps, is not the time and the place to discuss the question of whatever claims John Dalton may have to be the first to recognise the fundamental truth embodied in the statement that gases, under comparable conditions, contain in equal volumes equal numbers of molecules, whatever may be their nature and their weight. For the moment we are concerned only with the fact that it remained to Cannizzaro to show that the hypothesis afforded the means of placing the most important of all chemical constants—the atomic weights of the elements—on a definable and intelligible basis, and thereby of rendering our conceptions of atoms and molecules, atomic weight and molecular weight, of gaseous volumes and valency, and of all that is associated with or follows from these conceptions, more logical, consistent, and harmonious. What Cannizzaro did, in a word, was to throw light upon what was obscure, to introduce order where all was confused and contradictory. Hence his "Summary of a Course of Chemical Philosophy," published in 1858, will occupy in the history of chemical doctrine a position as a classic, not less honourable than Dalton's ever memorable "New System." There were, of course, difficulties to be overcome, and inconsistencies to be reconciled: certain facts, indeed, appeared to be hopelessly opposed to the hypothesis which Cannizzaro sought to make the corner-stone of the edifice of modern chemistry. But these difficulties have been gradually swept away, and the very facts which at first seemed incapable of being brought into line, are now seen to afford the strongest support to the truth and universality of the theory.

The theory of Avogadro, indeed, has been approached from independent, although converging standpoints, and its position is now secured by the concurrence of independent testimony. Mathematical conceptions of the nature of gases have shown its necessity. Chemical facts, for a time, were seemingly opposed to it, and hence it was neglected and ultimately forgotten by chemists. They were, however, being driven back to it in spite of themselves; and it in no sense detracts from his merit to affirm that even if Cannizzaro had not perceived the truth, the rapidly accumulating mass of evidence would have forced others to recognise it. Indeed the substantial unanimity with which Cannizzaro's doctrine was received, immediately that it became generally known, is a proof that the time was ready for it. It is not too much to say that its effect on the minds of chemical thinkers was as profound as that described by Cannizzaro himself in the memorable lecture before alluded to, when he reminded us of Thomas Thomson's account of the impression produced upon him by Dalton's own verbal explanation of the atomic theory. To paraphrase his words: they were enchanted with the new light which burst upon their minds, and saw at a glance the immense importance of such a theory.

Hence then, when Cannizzaro visited this country in 1872, to deliver the Faraday Lecture to the Fellows of the Chemical Society, of which he has been a Foreign Member since 1862, he spoke to willing and receptive ears, and to a body of men to whom his doctrine was already an established article of their chemical creed.

Cannizzaro is a Foreign Member of many learned Societies; nearly every Academy in Europe, indeed, has delighted to honour him. In 1889 he was elected a Foreign Member of our Royal Society, and two years later he was awarded the Copley Medal for his services to chemical theory. May he long be spared to wear the many honours he has so worthily earned, and to enjoy, in health and increasing prosperity, the respect and esteem of a multitude of friends in both hemispheres!

T. E. THORPE.

EXPERIMENTAL RESEARCHES ON THE PHYSIOLOGY OF REPRODUCTION.

Die Bedingungen der Fortpflanzung bei einigen Algen u. Pilzen. Von Dr. Georg Klebs, Professor in Basel. Mit 3 Tafeln u. 15 Text-figuren. (Jena: Gustav Fischer, 1896.)

IT has long been recognised that in the life cycle of a large number of plants and also of some animals two very distinct modes of reproduction, the sexual and the asexual, recur in a rhythmical fashion.

This fact, crystallised by Steenstrup in his famous doctrine of alternation of generations, has ranked as one of cardinal importance in the treatment of the higher groups of plants ever since Hofmeister showed that the sequence of events in their several life-histories was essentially identical with that obtaining in a moss or in a fern. True it is that in respect of algæ and fungi there existed an uncomfortable *arrière pensée* that all was not quite right, and indeed certain facts seem to be definitely opposed to the general extension of the doctrine to the various members of these classes. Curiously enough it seems not at once to have been clearly apprehended that one has hardly any right to expect to find alternation recurring regularly in these primitive forms; for the very characters which we regard as indicative of primitiveness consist exactly in those negative conditions implied in an, as yet, undeveloped state of division of labour. But it is obvious that, before alternation could possibly have become part of the regular physiological (and

morphological) peculiarities of the race, a good deal of initial specialisation must first have occurred; this will be equally true, whatever view we choose to adopt as to the homologous or antithetic nature of the origin of the process itself.

In the highest forms, we are very far from being able to answer the initial question as to what it is which causes the organism to enter on the reproductive as opposed to the vegetative phase, although as regards the actual phenomena of reproduction itself, we can fairly accurately predict the course which the process will take. But this is merely because it is far less directly affected by the action of the environment than are the functions of nutrition and growth. Nevertheless, although the empirical facts may be easier to glean, their very invariability opposes perhaps the strongest obstacle to our grasping the nature of the chain of causes of which they themselves merely constitute the terminal expression.

But in the lower forms, including most algæ and fungi, the physiological differentiation has not progressed far enough to effect such an adjusted state of organisation as will commonly respond in an identical manner to the action of any stimulus whatever that may happen to be able to excite it at all, for they will either grow vegetatively, or they will reproduce themselves sexually or asexually, according as the exigencies of the environment may demand. It is to them, therefore, that we look to find the clue that shall enable us to penetrate the dense obscurity which at present veils the whole subject.

But although reproduction and the conditions which affect it has long afforded a favourite theme for speculation, its investigation from a scientific and experimental standpoint has been surprisingly neglected. A certain amount of scattered knowledge has been gathered, owing largely to the efforts of gardeners and others practically interested in the solutions of the problems with which we are here concerned, but for definite attempts at thorough investigation by means of inquiries properly formulated and vigorously pursued we have looked, until lately, almost in vain.

Prof. Klebs, then, is the more deserving of the congratulations of all who are interested in these difficult problems on account of the admirable manner in which he has conceived and conducted his elaborate and beautiful series of experiments which are described in the volume before us. For his results conclusively prove that these recondite functions of protoplasm are as amenable to experimental treatment, if approached in a suitable manner, as are those of irritability or of nutrition. It is difficult at present to estimate the exact limitation of Dr. Klebs' methods or the general value of his conclusions, but the results as yet obtained are truly surprising. Instead of uncertainty, we find definite reactions on the part of the organism to varied external conditions, and the present writer can testify to the accuracy of the author's statements in a number of crucial instances.

Of course it is impossible here to give more than a mere sketch of the enormous mass of detailed observation piled up, in a rather unwieldy fashion it must be confessed, in Prof. Klebs' book, but a few typical facts will serve to indicate the general drift both of his methods and his results.

A somewhat large proportion of the entire number of pages is devoted to an account of *Vaucheria terrestris*, of which the author recognises three varieties which showed differences, sometimes slight, sometimes rather striking in the respective manner in which they responded to similar stimuli, but for the details the original treatise may be consulted. The plants were investigated with a view of determining the conditions which govern the formation of the non-sexual zoospores and the sexual gametes respectively, and especial attention was directed to the influence of heat, light, medium of cultivation, organic or inorganic food, and so forth. Dealing with the alga at first from the point of view of its zoospore-formation, a large number of striking facts was elicited. It must be premised that *Vaucheria* only forms zoospores when it is growing immersed in water; but, as will be seen, this is only a very small part of the story, since the conditions to which it happens to have been previously exposed when growing in terrestrial stations have an important influence in determining whether, on immersion, these bodies shall or shall not be produced. For example, if plants which have been grown on soil in a damp atmosphere be suddenly submerged in water, zoospores are copiously produced within a short time, and this is especially the case if the submergence be accompanied by a darkening of the culture, whereas if a *dry* earth culture be similarly treated zoospores may perhaps not be produced at all. They are, in any case, only formed in the upright filaments, such as may be seen rising up abundantly in any specimens cultivated in damp air. Furthermore, the change from an aërial to an aquatic medium must be a sudden one. A gradual submergence produces no effect, and this fact gives us a probable clue to the cause of the failure of plants which have previously been kept dry to form zoospores after immersion. Under these circumstances the erect filaments are not produced, and by the time they do appear in the water culture, the stimulating effect of the change of medium seems to have ceased to operate.

As regards the action of changes of temperature, it was found that in general a rise of a few degrees provoked the formation of the zoospores, especially when the plants were grown at low temperatures, but that the converse process of cooling was without effect. The interesting discovery was made, that whereas the lowest normal limit at which the plants could thrive and retain their sensitivity was about 3° C., this could be considerably lowered by gradually accustoming the plants to increased cold, and that under these circumstances they still responded to an increase of warmth in the usual manner, *i.e.* by the production of a crop of zoospores.

Much interesting matter is to be found in the pages devoted to the consideration of other conditions affecting the production of zoospores; but in this place we will content ourselves with indicating some of the more important ones connected with the influence of light. In water-cultures grown under healthy conditions, zoospores are readily produced on the withdrawal or diminution of light. It turns out that plants exposed to blue light behave as in the dark, *i.e.* they form zoospores, but that in yellow rays these bodies are not produced. It might seem natural, at first sight, to connect this peculiarity in some way with the assimilatory functions which are

discharged in yellow light; but Klebs decides against this, urging that plants grown in air freed from carbon dioxide behave in the same manner. He does not believe that the small amount of assimilation, which can occur by means of the carbon dioxide set free during respiration, can account for the process. Still, it must be admitted that this is an objection which is not devoid of some weight; and the fact that plants grown in certain mineral solutions *only* form zoospores *during light*, seems to indicate that nutrition may yet be found to lie indirectly at the bottom of the matter. At any rate, a good deal more analysis of the conditions is here necessary before we can safely formulate any theory. Klebs himself goes on to speak of the darkness itself as constituting a *reiz* or stimulus; but it is not very easy to see how a negative condition can be quite appropriately so construed. May not the light, or at least the yellow constituent rays, be regarded as exerting a tonic or inhibitory effect, which must first be withdrawn before the already existing tendency can manifest itself in action? It is clear that the same objection might be urged in the case of some other so-called stimuli; but it seems very desirable to avoid any ambiguity of expression, especially in a subject already so difficult, such as is involved in the use of the word stimulus (*reiz*), both for an active promoting cause and for the removal of a restraining influence.

It is extremely instructive to contrast the conditions which excite the formation, in *Vaucheria*, of sexual or asexual reproductive organs respectively. Whereas darkness is advantageous in the case of the latter, the sexual organs are only produced in the presence of fairly strong light, which further must contain just those less refrangible (yellow) rays which inhibit the production of zoospores. The action of the light is here two-fold. Firstly it operates by promoting assimilation, and in this capacity it can largely be dispensed with, provided suitable carbohydrate food be supplied to the plant. Secondly it acts as a direct stimulus, which initiates the formation of the sexual organs, and in this capacity it cannot be replaced. But when once the stimulus has effected the inception of the sexual organs, they may continue to develop in greatly reduced light, the degree of maturity to which they finally attain being largely determined by the initial duration of the stimulus. In *Vaucheria* the oogonia require a stronger excitation than that sufficing to produce the antheridia; and consequently it is possible, by regulating the illumination, to raise plants bearing only male organs.

Similarly, Klebs determined the corresponding special conditions in the case of a considerable number of other algæ. Several of these are of particular interest as illustrating the individual vagaries and idiosyncrasies of the different species, and also as forcibly emphasising the danger of drawing general conclusions rom an insufficiently wide area of facts. For example, *Hydrodictyon* can be induced, as a general rule, to readily reproduce sexually or asexually at the will of the experimenter; but it occasionally happens, as the consequence of certain modes of cultivation, that it develops a very pronounced tendency to form zoospores only, and under these circumstances all the ordinary methods which are commonly efficacious in producing gametes are futile. The plant must first be broken of its tendency to form zoospores; and this can be done by keeping it at a high temperature, and in the dark. This inclination to a particular form of reproduction is of some significance when taken in connection with the difficulty, which is often experienced in many fungi, of securing any but the non-sexual form of reproduction; but it is of still wider interest as once more illustrating the fact that, although external stimuli may evoke this or that form of response, the actual form of the response itself is, after all, not so much determined by the nature of the stimulus as by the particular condition of the special protoplasmic mechanism through which it operates.

Another example may be quoted as illustrating the difficulty of drawing any general conclusion from Klebs' experiments at present. This is not meant by way of disparagement, for his results are in the highest degree useful as affording numerous exact data, even though they hold, it may be, only for isolated individual species. Thus two species of *Œdogonium* were investigated, namely, *Œd. diplandrum* and *Œd. capillare.* Both of these were found growing in the water, often side by side; and yet in hardly a single respect does the stimulus, adequate to provoke the formation of zoospores in the one species, produce a similar effect on the other. The chief differences may be shortly summarised as follows.

(1) In *Œd. diplandrum* a rise of temperature is one of the most effective means (provided too great heat be avoided), whereas in the case of *Œd. capillare* it produces absolutely no effect whatever.

(2) In *Œd. diplandrum* a transference from running to still water produces zoospores, whether in light or darkness; the diminution of oxygen apparently providing the real stimulus here. In *Œd. capillare*, on the other hand, the reaction only occurs in the darkness; the latter condition being, in this case, essential to success.

(3) In *Œd. diplandrum* light is absolutely without influence on the process, whilst in *Œd. capillare* it possesses a powerfully inhibitive action. That mere darkening is not the proximate cause of the zoospore formation, is proved by the fact that the process only begins after a prolonged stay (two days) in the dark; that is, probably, the withdrawal of light allows some change to proceed within the protoplasm, and that the effect of this is to act ultimately as a stimulus to the formation of the swarm-cells.

If anything were needed to show how important is the nature of the protoplasm in each individual instance when considering the result which may follow on identical external stimuli, it would be hard to conceive of a better example than that afforded by the behaviour of these two species of *Œdogonium.* What the nature of the internal mechanism may be, or how the stimuli actually affect it, is absolutely obscure—as obscure, indeed, as are the reactions of the plant to gravity or to the directive influence of light—so soon as we seek to penetrate beyond the region of mere empirical fact. In the case before us Klebs suggests that plasmolysis, and other disturbances of the normal relations of the salts dissolved in the cell-sap, may be the determining factor, but his arguments are not very convincing, and, indeed, such an hypothesis recalls the rough and ready "explanations" which used to be put forward as solving the riddles of heliotropism and the like; but

quite apart from this, some of his own direct observations appear to tell strongly against it.

The development of the *sexual* organs in these lower plants is much less variably affected by the influence of the surrounding conditions (a very significant fact, even in these primitive forms) than is that of the non-sexual ones. Light, in greater or less intensity, is commonly essential, and, as has been said in connection with *Vaucheria*, it acts both directly as an initiating stimulus, and indirectly as affecting the function of assimilation. Again, cultivation in a small amount of water, together with the absence or at least scarcity of inorganic nutrient salts, encourages their formation; whilst the addition of the last-named salts commonly suffices at once to check the process, and frequently causes the resumption of vegetative activity.

The case of Spirogyra is of some special interest in this connection, owing to the remarkable disturbances which the addition of appropriate salts may effect in cultures in which conjugation is freely proceeding. These disturbances may take the form, in weak organic salt solutions, of partial arrest of conjugation, the gametes then clothing themselves with a wall while still within their own mother-cells, and finally growing vegetatively as any ordinary separated cell of a filament would do. If, however, the solution be sufficiently concentrated, the gametes develop to form parthenospores indistinguishable, when mature, from true zygospores. Similar effects can be brought about by sugar solutions of appropriate strength. It is important, however, to notice that it is only at certain stages in the development of the gametes that their further development can be arrested, and parthenospore-formation be induced; and this, taken together with the varied behaviour exhibited by the different species, emphasises what has already been said as to the need of taking due account of the "personal equation" of the individual in all inquiries of this kind.

A number of valuable observations on fungi are also recorded in the book; but space forbids further mention of them here, beyond the one fact, which may prove of practical use to teachers, namely, that bread-cultures of *Eurotium* can be made to produce archicarps, &c., with certainty in about two days, if kept at a temperature of 28°—29° C.

Prof. Klebs, whilst mainly concerned with the problems of the physiology of reproduction, incidentally touches on several points of taxonomic interest, and, in particular, he clears up the difficulties which have often been felt with regard to *Botrydium*, by showing that two distinct organisms have been confounded under this name. He proposes to separate them into two genera, retaining one of them in the old genus *Botrydium*, and creating a new one—*Protosiphon*—to include the other.

It is quite impossible within comparatively moderate limits of space to do justice to the great wealth of observation and experiment recorded in the volume before us; the work is essentially one which everybody who is interested in the subject ought to study for himself; and if he finds it rather a bewildering treatise, he will, nevertheless, be amply repaid for his trouble, and may further take comfort from the fact that the author promises another volume in which the points of theoretical interest will be brought more nearly together, and their general bearings discussed. J. B. F.

SHAKESPEARIAN NATURAL HISTORY.

Natural History in Shakespeare's Time: being Extracts illustrative of the Subject as he knew it. By H. W. Seager. 8vo, pp. viii + 358. Illustrated. (London: Elliot Stock, 1896.)

WHETHER, as a student, absorbed in the dry details of systematic work, or whether, as a spectator, interested in the marvellous displays of our museums, we of the present day are too apt to forget that natural history has lost one of the greatest of all charms—the charm of the unknown and the mysterious. To us a new animal merely fills one more gap—it may be large or it may be small—in the chain of nature; its interest, unless it be of striking form and beauty, or have something out of the common in its structure, being generally confined to the specialist. Not so the naturalist (save the mark!) of Shakespeare's day. To him the voyager, on his return to his native land, brought some new legend of the cockatrice, the mermaid, the phœnix, or the unicorn, or told of creatures the like of which had never before been heard of in heaven or earth. It mattered not that *spolia opima*, in the shape of talons, skins, eggs, or feathers, were not to the fore to confirm the story; there the story was, and that sufficed.

Now that the cold light of science has thrown its ray upon the most remote parts of our globe, there is no longer room for legendary creatures—save the sea-serpent; and we are told that the mermaid is nothing more than a dugong, a unicorn either a rhinoceros or a Tibetan antelope, while the cockatrice, the phœnix, and the roc appear to be pure imaginations.

But in the Elizabethan age—an age when the dodo had but recently been discovered—these, and many other mythical creatures, were, if not living, at all events actual realities to the ordinary public, and as such were referred to in the works of the great dramatist and other contemporary writers. We meet, for instance, in the *Winter's Tale* the line, "Make me not sighted like the basilisk," and in the *Tempest*, "Now I will believe that there are unicorns." But not only was more or less of credulity given to the existence of these and such-like fabulous monsters, but a web of mystic lore encircled the most common and best known of beasts, birds, and fishes. Who, for instance, is forgetful of the popular superstitions connected with the salamander, the newt, and the blindworm, and who fails to remember White's account of the "shrew-ash" at Selborne? And if such superstitions still survive among uneducated peasants of the present day, we may be assured that two centuries ago they were fully believed by the higher classes.

As the author states in his preface, the work before us "presents in a convenient form for reference a collection of the quaint theories about Natural History accepted by Shakespeare and his contemporaries. . . . The plan of the book is to give some illustration of each word mentioned by Shakespeare when there is anything remarkable to be noted about it." It is added that the term Natural History is taken to include not only plants as well as animals, but likewise some precious stones. It is further stated, that although Shakespeare had a greater knowledge of natural history than many of his contemporaries, yet that even he gave credence to many

of the legends he quotes, especially in regard to the animals and plants of distant lands.

The early writers whom the author quotes as his authorities form a long list of names. Among them are Friar Bartholomew and his editor Batman, whose works seem to have been the standard natural history of Shakespeare's boyhood; Topsell, so beloved of the late J. G. Wood; Gerard and Parkinson, as known by their respective *Herbals*; Holland, in his translation of Pliny's Natural History; and Evelyn, of *Silva* fame. Long quotations from these and other writers are given under the heading of the more important animals, plants, and jewels; contemporary illustrations being in many instances reproduced.

Many of these latter are of the quaintest, and form puzzles for the naturalist to discover the animals from which they were compounded. The crocodile, for example, is represented as a very marvellous complex animal, having a head which can scarcely have been taken from aught else but a wild boar, while in the armature of its back and fore limbs it recalls a pangolin; and the panther (p. 131) is more like a spotted hyæna than the creature it is intended to portray. What can have been the origin of the eight-rayed crest on the head of the serpent (p. 280), it is hard indeed to guess. But the most marvellous creature of all is the reputed whale (p. 341), which is a pig-faced, four-legged, scaly animal, with a long tail ending in flukes; the creature being represented as having just climbed on the poop of a vessel, with its head high up among the rigging. It has surely much more connection with certain modern stories of the sea-serpent than with any whale that ever swam.

That the author has succeeded in producing a very delightful and, to a certain extent, an instructive volume, may be freely granted. At the same time, it would have been decidedly an improvement had he given some explanation of the legends connected with real animals and plants, and likewise have offered suggestions as to the origin of mythical ones. As it is, the reader is left almost or completely in the dark on both these points. It is not as if nothing had been written in modern times upon such subjects. For instance, we find on p. 11 the following sentence: "And it is said that in Ethiopia be Ants shap [ed] as hornets, and diggeth up golden gravel with their feet, and keep it that it be not taken away." Now if the author had consulted a paper by the late Dr. Valentine Ball, published some years ago, we believe, in the *Proceedings of the Royal Irish Academy*, he would have found some interesting information concerning these gold-digging ants, and also about many legends connected with other animals, both real and fabulous. Again, when treating of sirens, or mermaids, the non-scientific reader would probably like to have been informed that the legend almost certainly originated from dugongs having been mistaken for sea-maidens. All that the early writers have said of the unicorn is very fully given, but a few words as to what modern authorities think as to the origin of the myth would surely have been acceptable. As it stands, we can, however, confidently recommend the work to all who are interested in learning what were the views of our non-scientific ancestors of two centuries ago as to the habits and uses of animals and plants of their own and foreign lands.

R. L.

OUR BOOK SHELF.

Chapters on the Aims and Practice of Teaching. Edited by Prof. Frederic Spencer, M.A., Ph.D. Pp. viii + 284. (Cambridge: University Press, 1897.)

THIS book should be read by all who are interested in educational methods. With the chapters on the teaching of Greek, Latin, French, German, English and History, we are not much concerned; our only regret is that the methods of teaching languages described therein were not in use in our own schooldays.

As to the chapters on the teaching of various branches of science, we commend them to every earnest teacher. Geography is dealt with by Mr. H. Yule Oldham, who, beginning with the consideration of position, distance and area, as exemplified in the schoolground and parish, passes therefrom to the consideration of the British Isles and the earth as a whole. The plan of study he sketches makes geography a living science, instead of a demoralising exercise for the memory. Prof. G. B. Mathews plans an algebra course, and urges that the natural approach to the study of it is by the way of ordinary arithmetic. After simple arithmetical algebra come rules of sign, negative quantities, factors, geometrical progression, and then surds. The way to teach geometry is shown by Mr. W. P. Workman, whose many suggestive and practical hints will, perhaps, help teachers to see that the main function of the subject is intellectual discipline.

Methods of teaching physical science are described by Dr. R. W. Stewart. The method of teaching advocated involves theory, demonstrations, and individual laboratory work, but the research attitude of the learner is not advised; for, says Dr. Stewart, "Experimental work is of no value whatever unless the theoretical knowledge of the scholar is full enough to enable him to understand clearly the objects and the details of the experiment." Against this view we have Dr. H. E. Armstrong's remark, in his very helpful chapter on the teaching of chemistry, that "students are not to be *told* about things, or even to be *shown* things, but are to be trained to *solve problems* by experiment—that is to say, they are to be trained to *discover*; and their discoveries are to have reference to common objects and phenomena." Two brief chapters on the teaching of botany and physiology, by Prof. R. W. Phillips and Dr. Alexander Hill respectively, conclude the volume.

Education in this country will certainly gain by the publication of these chapters on pedagogic methods.

Star Atlas. By W. Upton. Pp. iv + 29, and plates. (London, and Boston, U.S.A.: Ginn and Co., 1896.)

THIS atlas is primarily intended as an educational guide for the amateur astronomer; and with this end in view, no stars fainter than the sixth magnitude have been charted, thus avoiding the crowding in of detail inseparable from more complete star atlases.

Stereographic projection is adopted throughout the series of six maps, two of which are circumpolar, showing northern and southern stars; the remaining four cover the regions lying between N. 40° and S. 40° declination.

In addition there are six key maps, plotted to half the scale of the principal series, showing only the chief stars, and having connecting lines drawn between the stars of each constellation. These will be found useful in passing from one constellation to another when searching for an object.

The explanatory text gives a brief outline of the history of the formation of constellation-areas, the names and designations of the stars, and the system of indicating magnitudes. Very representative and concise catalogues of double stars and nebulæ are given, and following these are lists of variable and coloured stars. The lettering and outlining of the groups is very legible; but it still seems usual for the ancient constellation figures to mask somewhat the resemblance of a star chart to the sky as

seen by the eye. It would be better if these were put in as finely as possible, if included at all. The atlas is well up-to-date; and, owing to this fact, will probably be useful to the professional as well as to the amateur. The star places are marked for the epoch 1900, and the Harvard photometry has been taken as the authority for the magnitudes, the positions being derived chiefly from Argelander's Uranometria Nova. For observers possessed of instruments of moderate size, this atlas will probably prove a useful companion.

A Protest against the Modern Development of Unmusical Tone. By Thomas C. Lewis. Pp. 46. (London: Chiswick Press, 1897.)

THE prevalent practice in organ-building of the present day is to use for the middle C a pipe too large in scale, and with mouths cut too high, the result being, according to the author, that the Diapason tone, which rules every other stop in an organ, has deteriorated in quality. A pipe which will give an ideal Diapason tone is specified, and the defects in organs which do not conform to the conditions laid down are criticised. The protest as regards church bells is chiefly directed against excessive thickness. In pianofortes the destruction of pure tone is held to be due "to an increase of heaviness in the hammers for the pounding of the strings, to an excess of rigidity in the framework and setting, counteracting the vibrating motion of the strings—to an excess of scale in the length of strings—to the production of false harmonics, and the absence of due proportion between the ground-tone and the harmonics, and generally to the making of more noise than music in the quality heard." The brochure contains some interesting information on the principles of the construction of organ-pipes, bells, and pianofortes.

Respiratory Proteids, Researches in Biological Chemistry. By A. B. Griffiths, Ph.D. Pp. v + 126. (London: L. Reeve and Co., 1897.)

THE conclusion which the author of this book aims at establishing is that there are several respiratory proteids (both coloured and colourless) in the blood of animals. The introductory chapter, occupying one-third of the pages of the book, brings together some interesting information on the constitution of the blood of echinoderms, annelids, insects, arachnids, crustaceans, molluscs and vertebrates. Following this are chapters on various respiratory pigments found in the blood of certain animals, and on colourless respiratory proteids. Chapters on the nature and functions of chlorophyll and hæmoglobin conclude the text. An appendix is devoted to brief descriptions of the chemical compositions of the chief pigments which occur in the bodies of animals, and the methods by which they may be extracted.

The book should be serviceable in directing attention to the comparatively neglected field of biological chemistry, even if all the views it contains as to biochemical processes are not accepted.

Outlines of Psychology. By Wilhelm Wundt. Translated by C. H. Judd. Pp. xviii + 342. (Leipzig: Wm. Engelmann. London: Williams and Norgate, 1897.)

THIS book differs from the other works of Prof. Wundt in being more purely psychological, the physiological aspect of the subject being kept as much as possible in the background. Like the other works, it is an exposition of the special attitude of the author rather than a critical account of the present state of knowledge on the subject; but this is a feature common to most psychological text-books. For those who wish to learn the views held by the leader of one of the chief schools of modern psychology, the present volume will serve excellently. The translation is good, and Dr. Judd has added a useful glossary giving the German equivalents of the chief psychological terms used.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Organised or Sectional Work in Astronomy.

THE remark was recently made by Prof. S. C. Chandler that, notwithstanding there had been no recent systematic arrangement of work in connection with variable stars, the result was most gratifying; for the observations were fairly complete, few interesting objects having been neglected. He says that "this satisfactory result could hardly have been reached so effectively by a formal organisation of work directed from headquarters, prescribing and circumscribing the operations of each participant, and destroying by its benumbing influence the enthusiasm which springs from the individual initiative of the observers themselves."

This statement emanating, as it does, from a thoroughly practical man, and being based on unequivocal facts, must commend itself to the consideration of every one interested or engaged in the sectional work of various societies. It is evidently a point worth inquiry, as to whether Prof. Chandler's remark applies with equal force to other departments of astronomy besides that of variable stars. Having had some little experience in the sectional work of the Liverpool and other astronomical associations, I may perhaps be allowed to express the opinion that, while in some branches there is great utility in co-operation, in others the material advantage is rather questionable. In comet-seeking the division of labour seems eminently desirable, because one observer cannot possibly examine all the available sky at sufficiently short intervals. In meteoric researches, also, concerted effort is most valuable for the purpose of securing duplicate observations. Amateurs, by pre-arranging the hours for simultaneously watching the heavens, and the particular region for each one to observe, are enabled to secure a number of observations of identical objects, and the real paths of these may be derived from the materials gathered in this way. If left to independent effort, the chances of success would be greatly diminished, and the accuracy of the observations impaired; for a person when engaged in special combined work is apt to put forth his best energies, and the appearance of a large meteor is not likely to find him unprepared, unless it comes at a time not included in the prescribed hours of work.

But, in some other departments of observation, there does not appear to exist the same necessity for organised effort. In fact, I think that it can be shown from results—the best of all tests—that it has been a comparative failure as far as it affects the progress of astronomy. Of course a great deal depends upon the director of a section. If he is a man of great resource and skill, he will be pretty sure to have something tangible to show for his work, and that of his colleagues. The worst of it is that, in publishing collective results, the good, bad, and indifferent are indiscriminately presented; and there being, perhaps, no criterion by which to distinguish them, the whole are virtually rendered useless. Taking any band of unselected observers those of moderate or poor capacity will greatly predominate. Even in meteoric astronomy, I would not, for an instant, recommend that the results of several observers should be combined with the idea of accurately determining the positions of radiant points. In such cases the bad or moderate observations swamp the trustworthy ones, and we can get radiants anywhere or nowhere, just as we like to interpret the evidence afforded by the materials before us. It is a most important requirement that really precise observations should be preserved from contact or collaboration with others of inferior character.

A little reflection will prove that all the best work has been accomplished by individual and independent effort. A good man will persevere in his labours, just the same, whether he belongs to any combination or not; and it is really much better for such a person to be isolated, so that he may perform the work of his choice in his own way, and publish it in his own style. If a man has the ability to accomplish useful work, he will know the best form in which it may be presented for the benefit of science. Moreover, he needs no encouragement; he proceeds with his research because he is actuated by the love of it, and sees the beacon of success shining invitingly in the foreground.

Undoubtedly, cases could be cited where combined work has been or will be most efficacious. In an object of exceptional

kind, like that involved in the preparation of the photographic chart of the heavens, it was absolutely necessary, from the magnitude of the undertaking, that a collective effort should be made. In another case, that of the British Association Committee on Luminous Meteors, which existed between 1848 and 1881, a mass of valuable work was performed (as the annual reports will testify) by the collection and discussion of observations and investigation of theories. Other instances might be adduced, but they are rather exceptional in character and distinct to the ordinary sectional work of societies.

In certain respects, it cannot be denied that the latter serve a useful purpose. Many gentlemen find it an encouragement and a source of interest to engage with others in combined work. They are thus enabled to compare notes, and it is a satisfaction to feel that a bond of association exists between them, and that they are all actively employed in a similar direction. Observations are taken, drawings are made, and many hours are spent at the telescope, which would never be so employed but for the influence of the circumstances referred to. They have the pleasure of seeing their observations in print; possibly some of their drawings are also reproduced, and the consciousness of having done something to merit public notice cannot fail to stimulate them to further effort. But, in such cases, it must be admitted that the benefit to science is inconsiderable. Very little work of real value is accomplished in this way, and in many instances the observations are not properly reduced and utilised as they should be. It is not sufficient that results of this kind should be simply allowed, year after year, to accumulate. Many thousands of drawings and observations have been made by the members of planetary sections; but we can trace very few salient facts, or additions to our knowledge, as the outcome of them all. Observers, as a rule, do not probe into their subject with sufficient depth, and ferret out all the details possible of any particular object observed. Nor is attention always directed to those points which are the most significant and suggestive. It needs a man like Mr. Marth to be the really efficient director of a section, to single out the really essential work to be performed, and then to sift it with thoroughness and critical accuracy.

To beginners sectional work is often most beneficial, as it affords them a useful preliminary training. But observers who need and will submit to "direction," except at the outset of their careers, are not generally the men who accomplish work of an important and enduring kind. The aspirations of a really capable man are not likely to be satisfied by the facilities offered by combination with many others. It has been said, "Talent does what it can, Genius does what it must." When a young observer begins to feel confidence in himself, it is, perhaps, better that he should strike out in a path of his own. There are some who will naturally be allured by the prospects of doing original work, and effecting discoveries in an independent way. They do not want to triple the channels of Mars, to distinguish the hard straight lines on Mercury and Venus, or to trace the zebra-leopard-like aspect of the globe of Saturn. But they want to do really useful work, and to rely only upon the unmistakable evidence of their eyes; in this respect, dissociating themselves from some modern observers, who can but very vaguely discriminate between romance and reality.

To sum up the matter: it appears that the organised work of "sections," though it unquestionably affords a stimulus to many, and assists in maintaining the interest in a subject, is yet. except in certain special circumstances and cases, disappointing and unproductive of results which materially advance astronomy. Individual and independent effort has hitherto been, and will still continue to be, the fountain-head of the most valuable work.

In concluding, it may be mentioned that the issues of recent planetary observation appear to be totally dissimilar to anything previously experienced in astronomical history. No two observers see alike when they examine the images of Mercury, Venus, Mars, or Saturn, and the actual character of the visible surface markings of these orbs is more an enigma than it was in the days of Herschel and Schroeter. There is also a pronounced conflict of opinion as to the utility of large and small telescopes in displaying delicate features on the planets. This want of unanimity amongst observers has become a serious question to consider; in its presence organised attempts to study the planets are of little avail, since many individuals seem to display their own particular idiosyncrasies and peccadilloes, greatly to the chagrin of every director of a section, who finds his post no sinecure.

W. F. DENNING.

Shelly Glacial Deposits.

I FEAR that the hope expressed by Prof. Bonney, somewhat incongruously in its connection, in his recent review of Russell's "Glaciers of North America," that "perhaps in future we shall hear less of rampant ice-sheets at Gloppa and Moel Tryfan!" is not destined to be fulfilled. There will be something more to hear shortly, if he care to listen, respecting that part of this ice-sheet which covered the Isle of Man. This portion was distinctly of the "rampant" type, as Mr. P. F. Kendall has already shown, carrying up shells in one place, and boulders of Foxdale granite in another, and erratics from the south of Scotland in another, as a matter of every-day work—just as recent investigations have shown to be the case in regions where to-day there are glaciers of other than the Alpine type.

I am quite in agreement with Prof. Bonney when, elsewhere in his review, he asks: "May not the difficulties of the subject be augmented by defective knowledge?" For this reason I may be pardoned for once more dragging forward the facts which I put on record some years ago respecting the shelly Basement Clay of the Yorkshire Coast. In this deposit the shells occur not only scattered throughout the clay, but also in limited patches or boulders of marine sand and mud, which are associated with similar masses of peat and mud of fresh-water origin, and with patches of shale and clay derived from the Lower Cretaceous and Jurassic strata of the country farther northward with the bedding still preserved and the characteristic fossils in place.

These facts have never been impugned, but they are rarely referred to by the opponents of the "rampant ice-sheets." They have surely a more immediate and direct bearing upon the subject than the isolated observation respecting the deposit in the neighbourhood of the Malaspina Glacier on which Prof. Bonney leans so wide a hope.

If the sands and gravels accompanying this Yorkshire drift-series be, as is usually held, the result of the washing-out of the same material, the shelly fragments contained therein are no better proof that the gravels are of marine origin than their derivative Jurassic fossils are that they are of Jurassic age.

I do not think that any one has attempted to deny that marine deposits of Glacial age may and do exist within the limits of the British Islands. But what the "extreme glacialists" wish to insist upon is that better evidence is required than the mere presence of sporadic marine organisms to prove such origin against the very strong evidence which can be adduced against it in such instances as those referred to by Prof. Bonney.

Dalby, Isle of Man, April 22. G. W. LAMPLUGH.

Sieve for Primes.

MAY I draw the attention of your readers to a series from which the primes may be recovered?

The series is given below, together with the accompanying primes.

1,	4,	11,	29,	76,	199,	521,	1364,	3571,	9349,	&c.
1.	3.	5.	7.		11.	13.		17.	19,	&c.
		2.								

The law of formation is $a_{n+1} \equiv 3a_n - a_{n-1}$.

It can be proved in various ways that the nth term of

$$(w_2 + w_3)^{2n-1} + (w_4 \div w_5)^{2n-1} - 1 \equiv p.q$$

where the roots are the unreal of $x^5 + 1 \equiv 0$ and $p = 2n - 1$ is any odd prime.

Is 13 a prime? Yes; because the 7th term ($2 \times 7 - 1 = 13$) minus unity $= 13\,q$.

Is 15 a prime? No; because the 8th term less unity is not $= 15\,q$.

These are but easy numbers to test; but the law is general.

We have here an alternative test for primes.

The series given above is intimately connected with the well-known "continuant" series 1, 1, 2, 3, 5, 8, 13, &c., whose law of formation is obvious.

The connection between the two series is as follows:—

Let a, b, be any two consecutive terms of the "continuant" series.

Then $5\,ab \pm 1$ will give the corresponding term in the former series.

There are other series which produce the primes, but the above can be produced *mechanically*.

I append a short proof, out of several which may be given. We have to show that

$$(w_2 + w_3)^{2n-1} + (w_4 + w_5)^{2n-1} \equiv 1 \bmod 2n - 1$$

when, and when only $2n - 1$ is prime.

Let w_2, w_3, w_4, w_5 be the unreal roots of $x^5 + 1 \equiv 0$ and $2n - 1 =$ any odd prime, then we may say

$$\left(\frac{1+\sqrt{5}}{2}\right)^p + \left(\frac{1-\sqrt{5}}{2}\right) = 1 \bmod p$$

$$= \left\{\frac{1 + pk + (\sqrt{5})^p}{2^p}\right\} + \left\{\frac{1 - pl - (\sqrt{5})^p}{2^p}\right\} = 1 \bmod p \text{ where } p$$

is any *odd* prime.

$$= \frac{2 + 2\,p.m}{2^p} = 1 \bmod p \text{ or } \frac{1 + p.m}{2^{p-1}} = 1 \bmod p.$$

Now, by Fermat's theorem $2^{p-1} - 1 = p.n$ when, and when only p is prime. Thus

$$p.m - p.n = 0 \bmod p$$

which proves the theorem for any *odd* prime.

It is also true for $p = 2$, since by ordinary work

$$\frac{1 + 2\sqrt{5} + 5}{4} + \frac{1 - 2\sqrt{5} + 5}{4} = 3 = 1 \bmod 2.$$

Thus the theorem is universally true for all primes.

It is remarkable that the second factor of the prime series given above is also a function of the prime p, viz.:

$$1 + \frac{p-3}{2!} + \frac{p-4 \cdot p-5}{3!} + \frac{p-5 \cdot p-6 \quad p-7}{4!} +, \text{\&c.}$$

ex. gr. the 4th term of the prime series is 29, thus

$$29 - 1 = 7\left\{1 + \frac{7-3}{2!} + \frac{7-4 \cdot 7-5 \cdot}{3!}\right\} = 7\{1 + 2 + 1\} = 28.$$

As this communication is somewhat long, I reserve the proof of this. ROBT. W. D. CHRISTIE.

April 28.

The Effect of Sunlight on the Tints of Birds' Eggs.

THE beautiful and delicate colours observed on the eggs of birds are not very fast to light, more especially when they belong to the lighter class of colours. Egg-collections should be carefully protected from the light by some covering over the case, when they are not being inspected; otherwise much of their beauty of tint becomes lost in course of time. It is gratifying to notice that in museums and natural history collections this precaution of protecting egg-cases with covers is now almost universally observed. In many instances some of the finest and most characteristic tints of several eggs disappear on exposure to much sunlight. A common example may be found in the beautiful pale blue of the starling's egg (*Sturnus vulgaris*). This, on exposure to sunlight for a few days, loses its clear blueness of tone, and becomes purplier, approaching more to the slate tint. Such is also the case with most of the greenish-blue eggs, like those of many sea-birds, the common guillemot's (*Uria troile*), for instance, the beauty of which largely depends on the clear freshness of its blue tints. The writer, some time ago, made some experiments on the fastness to sunlight of those egg-tints. The method employed was a very simple one, and may be briefly described as follows. Various birds' eggs were selected for experiment, those having decided and well-marked colours being preferred. These shells were halved lengthwise, care being taken before the operation to divide it so that each half should, as nearly as possible, present the same amount of colouring. One half was kept from the light for future comparison, while the other half was exposed in a glass case to direct sunshine. After various exposures, amounting to one hundred hours' sunshine, each exposed half was then compared with its unexposed counterpart, and the changes in hue carefully noted. Little change was visible in the darker coloured eggs of the olive-brown or chocolate depth, but in the lighter tints, especially among the blues and green-blues, the changes became more marked. Among the darker shades of eggs was the common curlew's or whaup (*Numenius arquata*), with its dull olive-green spotted with deep shades of brown; and also the lapwing (*Vanellus cistatus*), which closely resembles in general appearance that of the curlew. Such deeply-coloured eggs are little altered on exposure to light, unless after very long exposure, when they lose some of their rich warmth of tone, and become a trifle clearer in their ground tints, making them look somewhat bleached. Many sea-birds' eggs have a bluish-green colour—sea-green it might be called—which, when new and unexposed, is rich and beautiful. This clear tint, however, is lost on exposure, and it assumes a more dingy slate hue. Some of their eggs have a network of white chalk-like incrustation streaked over the bluish ground tint. This may be seen on the egg of the common cormorant (*Phalacrocorax carbo*). If such shells be exposed for several days to sunlight, and afterwards the white incrustation removed with a knife, the difference produced on the ground tint by exposure becomes at once apparent. The exposed parts will be found of a slaty, duller hue, more approaching a stone-grey tint; while the unexposed parts, protected by the incrustation, will reveal the original sea-green tint in all its freshness. Another example is the fair blue egg of the common thrush or mavis (*Turdus musicus*). This egg when newly laid is of soft light blue of a fine shade, but on exposure it loses much of this clearness of tint, and becomes dull and purply, tending more to a leaden hue. Many similar examples might be given of beautiful shades of blue and blue-green tinted eggs which all tend to become redder and duller on exposure. The red blotched egg of the fieldfare (*Turdus pilaris*) fades in this manner, and the red markings assume a lighter rusty-brown hue. The ring ouzel (*Turdus torquatus*) so well known for its predatory visits to the strawberry-beds, has an egg closely resembling the fieldfare's, both in ground tint and markings, which undergoes the same changes in every respect. One of the commonest eggs is that of the blackbird; it also loses its greenish hue and becomes more of a stone-grey, while its varied markings lose considerably in depth. In the beautiful eggs of the yellow hammer (*Emberiza citrinella*), so curiously veined and mottled with dark red-brown over a pale ground, little or no fading was visible after exposure. Its markings may thus be considered fast to light. There are but few coloured eggs which show no appreciable change after so severe an exposure test as 100 hours' direct sunlight. A good example of a fairly fast-coloured egg is that of the favourite songster the skylark (*Alauda arvensis*). Its eggs vary considerably in colour, but they are always of an indescribable hue, sometimes an ashy brown, or a dark purplish grey, other times more of a greenish tinge. These stand the light very well. The specimens tested looked only a trifle bleached, but those having the greener tinge fade more. One of the prettiest of blue eggs is that of the the common hedge-sparrow. The loss of its clear blue tint to a purplish blue drab was most marked. To illustrate the unstable nature of egg-colouring in comparison with colours of different origin, various other colours resembling in tint those of the eggs were exposed in a similar manner. These were "distemper" colours, and water colours, painted on paper, and coal-tar colours dyed on wool. The distemper colours were perfectly fast to light; their colour constituents all being of mineral origin. The water colours examined were both of mineral and vegetable origin; those belonging to the latter faded very considerably. The coal-tar colours selected were mostly of the bluish cast, corresponding to many of the egg tints. The summary of the results obtained might be tabulated as follows:—

Colours examined.	Result after 100 hours' exposure.
Distemper colours...	100 per cent. fast.
Water colours	60 ,, ,,
Coal-tar colours	30 ,, ,,
Egg-shell colours	20 ,, ,,

The above results, along with the few common examples which have just been given, readily show that eggs lose much of their delicate and characteristic beauty of tint on being too freely exposed to sunlight. DAVID PATERSON.

Rosslyn, Midlothian.

Physiological Specific Characters.

PROF. R. MELDOLA, in his very suggestive presidential address to the Entomological Society, remarks (*Trans.* Ent. Soc. for 1896, Pt. v. p. lxxviii.):—"At any rate, it appears to me inconceivable that any change of environment requiring a modification of structure of sufficient magnitude to rank as diagnostic in the systematic sense, should not also be accompanied by a

greater or less amount of physiological readjustment." But in a foot-note on the very same page, in which he discusses the present writer's statement that specific characters are essentially physiological, he says :—"There must be so much in common in the physiological processes of allied species, that well-marked physiological differences cannot, without further evidence, be regarded as the universal characteristic of specific differences." These two statements are surely somewhat contradictory, and as the proposition I made appears to me to be a fundamental one, I desire to offer some explanatory remarks, especially as few critics will probably trouble themselves to look at the original paper.

I think Prof. Meldola, throughout his address, uses the term "physiological" in too narrow a sense. Morphology, as I understand it, has to do with form, physiology with function. My contention was exactly that of Dr. Wallace, that specific characters have to do with function—are functional, or else coincide with those that are functional. They may be internal or external; an internal process is no more "physiological" than an external one.

But I pointed out, that the very same morphological characters may be specific in one form, varietal in another. The reason why they are specific in the one case is, that they have a physiological as well as morphological significance; they are variable in the other, because they have little or no functional value, although under new environment they may come to have such value, and then through selection become specific.

A dead insect appears equally important in all its parts; function no longer exists, and they are reduced to a common level. But how different is the living creature! Each part now has a special significance; it is a tool, and some tools are more important—more useful—than others. Just in proportion to their value are they elaborated, and kept to one pattern, or, sometimes, to a choice of two or more patterns, as in dimorphic or trimorphic species. Those who claim that specific characters exist without any reason, have got to explain why it is that the very same characters are constant in one form and variable in another; or sometimes even constant in one part of the range of a species, and utterly variable in another part.

Therefore, taking up the first-quoted sentence from Prof. Meldola, I would object that environment never does "require a modification of structure" which has not also a physiological meaning. It is not necessary, of course, that there should be a functional change in *kind*, it must very often be simply a change in *degree*.

In another part of my paper quoted (*Proc.* Phila. Acad., 1896, p. 45) I express more nearly what Prof. Meldola seems to have intended, but I use the term "constitutional," thus:—

"Furthermore, it is apparent that the earliest distinctions between species are at least often of a very subtle character, so that the workings of natural selection during the actual process of segregation are anything but easy to observe. And this need not surprise us when we reflect that among ourselves constitutional characters, not easily identified by any coincident structural features, play so large a part in determining our ability to reach manhood and beget offspring."

It must not be forgotten that in describing a new species, we always include *more* than the actual specific characters, although, as Prof. Meldola excellently points out, we always miss a large proportion of the latter. Generic, subgeneric, and sectional characters are built upon the specific characters of former ages, but they need not now possess a special function. They are, however, the groundwork on which new specific characters are built, and they constitute, in a sense, part of the environment which directs the moulding of those characters. It is when they come too directly in conflict with the external environment that the species becomes extinct. Thus species come to be judged by their ancestors.

A good instance of the correlation of function with structure is afforded by the wings of bees. These insects are classified largely on apparently trivial differences in the venation of the wings. But those who observe them in nature see that with these differences go differences in flight, and it is obvious that there must also exist important differences in the muscles of the thorax, so subtle that at present we know little or nothing about them. Even the psychological characters of these bees must differ. We do not yet know enough about the principles of insect flight to say exactly what influence slight changes in venation would have, but the influence need not be doubted. Recently, I discovered a new genus (*Philereumulus*) of bees with very peculiar venation, and its flight also was peculiar, rapid zigzags just above the surface of the ground, making it impossible to catch it in a net. Many bees can be caught by sweeping; *Centris*, with its hovering pendulum-like swing over the flowers it visits, must be caught by a rapid stroke, or it darts suddenly away.

Prof. Meldola, in his address, has ably shown the need for more subtle observations on the specific characters of insects, and if his suggestive remarks do not stir some of our entomologists up to new ways of work, it can only be because entomology, like astrology, has ceased to have any physiological significance—a thing no entomologist will be willing to admit!

Mesilla, New Mexico, U.S.A. T. D. A. COCKERELL.

AN ARCHÆOLOGICAL SURVEY OF THE BRITISH ISLANDS.

THOSE who are interested in the preservation and examination of ancient monuments should read the plea for "An Archæological Survey of the United Kingdom," which formed the subject of Dr. David Murray's presidential address to the Archæological Society of Glasgow, and which is reprinted in a convenient form by James MacLehose and Sons, of Glasgow.

This is a succinct account of the existing laws relative to antiquities, and of the "rights" or otherwise of the public. "Government spends large sums of money every year upon the preservation and protection of our records, the reproduction of fading charters, &c., but it does not regard the monuments which illustrate or supplement these records. Archæologists have raised the veil that shrouds the first epochs of man's life upon the earth, and have given us a glimpse of prehistoric times, but Government does nothing to collect or preserve the material which is essential for such investigations. The editing and interpretation of our Runic monuments we owe to Prof. George Stephens, of Copenhagen. For a record of the Roman inscriptions in this country we have to look to Germany or to Canada. Inscriptions and sculptures are of the same character as written monuments, and it is surely just as important that these should be carefully collected and accurately transcribed and photographed as that we should have new editions of the Chronicles of the Picts and Scots, or of the Exchequer Rolls of Scotland.

"The quaternary period is common ground to the geologist and the archæologist, the physical characters are dealt with in the Geological Survey. But why should the systematic survey stop at this point, or be limited to the requirements of geological science? The monuments which are witnesses to man's presence, his life and labour, are surely as worthy to be collected and preserved as the fossil remains of extinct fauna and flora.

"The monuments of the past are not indeed wholly neglected by Government, for if an object be in itself artistic, in the opinion of the Science and Art Department, it has the sedulous care of that Department, and no money is grudged for its protection and reproduction. The Ardagh chalice, for instance, is of this description; but a Roman altar or a centurial stone, no matter how valuable it may be historically, is passed by. Can anything be more inconsistent? To limit ourselves to the artistic side of man's nature will give but a partial view. We wish to know his life as a whole, his surroundings, his pursuits, and manner of living—everything, in fact, that enables us to trace the growth and development of culture and civilisation. For this purpose the undesigned and unwritten records of the past must be systematically ascertained, protected, and preserved, and, if need be, copied or reproduced. To do this effectually Government assistance is essential as a first step. It is a work that has been too long neglected, and should be no longer delayed. Let us at once and for ever wipe away the reproach that England is the only country in Europe

that does nothing to register and protect her ancient monuments."

It may be urged that we have the Ancient Monuments Protection Act, which Sir John Lubbock, after great labour, succeeded in passing through Parliament. This Act is valuable so far as it goes, but only 69 monuments in the British Islands (29 in England, 21 in Scotland, and 19 in Ireland) were specified in the schedule. Under Section 10 of the Act of 1882, Her Majesty may, by Order in Council, make additions to the list of monuments protected by the Act. This power has, however, been taken advantage of only to a very limited extent. It has been exercised on six occasions between 1887 and 1892, and 31 monuments (7 in England, 17 in Scotland, and 7 in Ireland) have been brought under the Act. Dr. Murray definitely states that "the Government have, in fact, rendered the Act inoperative, as regards the future, by steadily declining to accept further monuments even when offered to them." Ireland has been more fortunate; there are thus between 170 and 180 monuments in Ireland under public protection, as against 38 in Scotland and 36 in England.

Dr. Murray is not alone in his desire to see all our archæological remains preserved and described; but he has stated the case with enthusiasm and full knowledge in this little brochure.

Specialisation in scientific studies is necessary, but there is a great danger of weakness through sub-division. For example, archæological remains are relegated to archæologists and antiquarians, who are tacitly held responsible for them. Why should not professed historians and all who desire to intelligently understand the culture history of their native land, as well as of mankind in general, feel that they too are responsible for the record and preservation of these historical data? Few branches of unapplied science are of more national importance, and it would be well if the wave of patriotism that is now astir could be partially diverted towards this truly patriotic object.

THE INTERNATIONAL PHOTOGRAPHIC CATALOGUE AND CHART.

IN the month of May last year the permanent Comité International, for the execution of the Photographic Chart of the heavens, met at Paris to discuss various questions which had been left undecided at previous Conferences, and to inquire into the state of progress of the work of the various observatories participating in this international scheme. At these meetings, in addition to the members of the Committee, several guests were invited to be present and take part in the discussions.

The report of the proceedings, which has just been published, commences with a brief reference to the work of each of the observatories that is partaking in this scheme, the President (the late M. Tisserand) stating that the undertaking, as a whole, was in a satisfactory state of advancement. The report then refers somewhat in detail to the numerous questions that had been prepared for discussion at these May Conferences, from which we make the following brief abstracts.

With regard to the catalogue, the first resolution adopted, as the result of a special Committee of inquiry, composed of MM. Donner, Dunér, Jacoby, Paul Henry and Scheiner, was that the probable error of the values of the rectilinear coordinates measured on the plates ought to be as small as possible, and that the measures should be made such that this error should not exceed $0''\cdot20$.

It was further resolved to publish, as soon as possible, the rectilinear coordinates of the stars photographed, and that this publication should also contain the data necessary for converting these results into equatorial coordinates. The Committee expressed the desire that a provisional catalogue of right ascensions and declinations might be published by those observatories whose resources were sufficiently large. Each observatory is allowed to choose the positions of those stars of reference in the catalogues which appear the most convenient to them. For the calculation of the constants of the *clichés*, a minimum, if possible, of ten stars of reference must be allowed, and the adopted positions of these stars should be published. It was decided to postpone to a later date the discussion relative to the question of using a uniform system of constants for all the observatories for the reduction of the stars to the epoch 1900. All agreed, however, that an identical form of publication for all the observatories should be adopted, that of the catalogue of the Paris Observatory serving as the type. Each observatory can determine the photographic magnitudes, either by means of measurement or by estimation. The only stipulation the Committee imposes is that the methods employed must be such that the magnitudes in different observatories can be reduced to a common system.

With reference to the so-called photographic chart, five resolutions were adopted, namely:—

(1) That each observatory will be provided with a scale (furnished by Captain Abney) of densities, which will be impressed on the plates simultaneously with the *réseau*, by which the sensibility of each plate for the luminous objects of different intensities will be controlled.

(2) For the construction of the chart, the second series of *clichés*—that is, those whose centres are of unequal declination—will be exposed three times for a period of thirty minutes each. The time of exposure may be diminished if a decided increase in the sensibility of the photographed plate be noticed.

(3) The Committee selects, as the best method of reproducing the chart, the photogravure on copper from the *clichés*, with three exposures on them, the original scale being doubled.

(4) Each observatory will make two contact glass positives of each negative, one of which will be preserved in the building at Breteuil, part of the Bureau International des Poids et Mesures.

The next meeting of the Committee will probably occur on the occasion of the Universal Exhibition, in the year 1900.

NOTES.

THE announcement of the resignation of M. J. de Morgan, Director General of the Administration of Antiquities of Egypt, recently made by a contemporary, will be received with regret by many. It will be remembered that the duties of this gentleman were two-fold; he was supposed to excavate sites which promised good antiquarian results throughout Upper and Lower Egypt, and also to direct and manage the Ghizeh Museum near Cairo. It is not clear whether M. de Morgan has resigned both duties, but a well-founded rumour asserts that he is going to leave Egypt and to excavate in Persia on behalf of the French Government, who are said to have obtained a concession to dig for antiquities throughout the country, and to have leave to carry away whatever they may find. Whether M. de Morgan has severed his connection with Egypt wholly or partially matters very little relatively, but his resignation brings to the front the important question of what is to be done in the future about the conservation of the monuments which remain *in situ*, and those which are preserved in the National Museum. No one can deny that M. de Morgan has worked well in Egypt, and although much fault has been found with his "Catalogue" by those who have carefully read the work, none can deny that his excavations have been both thorough and successful, and that he has

imparted new life to that branch of the Antiquity Department which is under his immediate control. Still, however, it is manifest that the Director cannot be both excavating and managing the Museum in Cairo at the same time, and that while the excavations have flourished the Museum has languished. All that could be done in the Museum by a subordinate official has been done by Brugsch Bey, whose archæological knowledge is first-rate; and what has been done is well done. But very much more needs doing, and when the new Museum is built, if it is to be a successful and useful institution, it must have an adequate staff, led by a permanent *resident* official, whose duty shall be to arrange, classify, label, and describe the various objects, and make them accessible to visitors under proper supervision. No Museum can flourish under the rule of a chief, who not only is non resident, but is for several months of the year away excavating sites which are remote from centres of postal and telegraphic communication. It is much to be hoped that the English authorities in Egypt will insist on the appointment of a director or keeper of the Museum, and of an official inspector and excavator; each official should have a "free hand" in his own department, and each should be answerable to some Minister of the Government only. The system hitherto followed has disheartened the staff, and has retarded the proper arrangement of the antiquities in the Ghizeh Museum.

Sir Archibald Geikie arrived in America a few days ago, intending to remain about one month, and to deliver the Williams course of lectures on geology at the Johns Hopkins University, Baltimore. A reception was given to him by the section of geology and mineralogy of the New York Academy of Sciences, and addresses were delivered by Prof. J. J. Stevenson, president of the Academy; Prof. Kemp, president of the section; by the secretary of the section, and by Mr. Heilprin, of Philadelphia. Sir Archibald Geikie responded, after which the members of the Academy and invited guests were presented to him individually.

A very important meeting of the Council of the American Association for the Advancement of Science was held at Washington a few days ago. Prof. Theodore Gill, vice-president of the section of zoology, succeeded to the office of president in succession to the late Prof. Cope, by virtue of his seniority, under the constitutional clause which devolves the duties of president upon the senior vice-president in such contingencies. As Prof. Cope had not prepared his annual address, Prof. Gill was requested by vote of the Council to deliver the presidential address in the form of an obituary of the late president, which he consented to do. Secretary Putnam read correspondence with Mr. Vernon Harcourt, conveying the invitation to all members of the American Association to attend the Toronto meeting on the same terms as to payment of dues as the members of the British Association; and to the officers of the Association to attend as honorary members. The Council authorised Secretary Putnam to return the thanks of the Association, and to invite foreign visitors to attend the meeting at Detroit, calling attention to the clause which admits them to honorary membership without payment of dues. It was also voted to invite such guests to register as honorary members of the several sections in which they are specially interested. Dr. L. O. Howard, of Washington, was nominated by the Council as vice-president for the section of zoology for the approaching meeting, in the place of the late Dr. G. Brown Goode. Secretary Putnam reported, as the result of a recent visit to Detroit, that the accommodations, both as to hotel headquarters and to place of meeting, were much superior to any before available. The new and spacious Hotel Cardillac will be the headquarters, and the immense new High School the place of all the meetings and gatherings. The school building has a hall capable of seating 2500 persons, and ample rooms for the sections.

The annual visitation of Greenwich Observatory will take place on Saturday, June 5.

Mr. J. Wolfe Barry, C.B., F.R.S., and the Council of the Institution of Civil Engineers, have sent out invitations for a conversazione to be held at the Institution on Tuesday, May 25.

It is stated in *Die Natur* that the valuable library of the late Prof. Du Bois Reymond has been purchased by the Prussian Government, and will be presented to the Berlin Physiological Society.

Dr. Kolle, of the Berlin Institute for Infectious Diseases, has (says the *British Medical Journal*) received a year's leave in order to proceed to Cape Colony, where he has been commissioned by the Cape Government to carry on the work of Prof. Koch. He will continue the investigation into rinderpest and leprosy, and organise stations for the study of those diseases.

We regret to see the announcements of the death of the following men of science:—Prof. Léon du Pasquier, of Neuchâtel, author of a number of papers on the glacial geology of northern Switzerland; Mr. Hugh Nevill, of the Ceylon Civil Service, known by his zoological observations and collections; Dr. Magitot, member of the Paris Academy of Medicine, and one of the founders of the Société d'anthropologie; Edmund Neminar, formerly professor of mineralogy and petrography at Innsbruck; Dr. L. Martin, professor of mathematics at Klausenberg.

The question whether the public has a right-of-way over the Giant's Causeway has just been decided in the negative by the Vice-Chancellor in the Dublin Courts. We have already noted that a syndicate had purchased the Causeway, and that their action in closing it against the public, who had had free access to it from time immemorial, caused great irritation. A Committee was formed to support the public rights, and some members of it asserted them by walking over the Causeway, with the result that an injunction was asked for to restrain further trespass. A right-of-way was pleaded; but the Vice-Chancellor held that as the Causeway did not lead to any public place, this plea could not be upheld. It is stated that an appeal will be lodged against this judgment.

At the sixty-fifth annual meeting of the British Medical Association, to be held at Montreal from August 31 to September 3, inclusive, an address in Medicine will be given by Prof. W. Osler, an address in Surgery by Mr. W. M. Banks, and an address in Public Medicine by Dr. Herman M. Biggs. The president-elect is Dr. T. G. Roddick, professor of surgery in the Gill University, Montreal, and the sections, with their presidents, are as follows:—Medicine, Dr. Stephen Mackenzie. Surgery, Mr. Christopher Heath. Public Medicine, Dr. E. P. LaChapelle. Obstetrics and Gynæcology, Dr. W. J. Sinclair. Pharmacology and Therapeutics, Dr. D. J. Leech. Pathology and Bacteriology, Mr. Watson Cheyne, F.R.S. Psychology, Dr. R. M. Bucke. Ophthalmology, Mr. Edward Nettleship. Laryngology and Otology, Dr. Greville Macdonald. Anatomy and Physiology, Dr. Augustus D. Waller, F.R.S. Dermatology, Mr. Malcolm Morris.

It has been arranged shortly to hold a Conference of the members of the Institution of Civil Engineers in London, under conditions which, it is hoped, may be convenient to many who are precluded from attending the weekly meetings during the Session, and may prove serviceable to all by the discussion of a wider range of subjects than can be dealt with on ordinary

occasions. It is intended that the business of the Conference should differ from the ordinary proceedings of the Institution, in that papers descriptive of works executed should give place to brief statements concerning important debatable matters in engineering science and practice, introduced with a view to elicit discussion on the questions raised. This Conference is fixed for May 25, 26 and 27, the morning of each day (from 10.30 to 1.30) being devoted to the consideration of the above statements, and arrangements being made for inspections of engineering works in the afternoon. The work of the Conference will be carried out under the direction of the Council, with the assistance of seven sectional committees, consisting of members of the Institution, representative of various localities in the United Kingdom, and identified with the several branches of engineering. The sections and their chairmen are :—Railways: Sir Benjamin Baker, K.C.M.G. Harbours, Docks, and Canals: Mr. Harrison Hayter. Machinery and Transmission of Power: Sir Frederick Bramwell, Bart. Mining and Metallurgy: Mr. T. Forster Brown. Shipbuilding: Sir William H. White, K.C.B. Waterworks, Sewerage, and Gasworks: Mr. Mansergh; Applications of Electricity, Mr. Preece, C.B.

ENGLISH weather is as fruitful a subject for composition as it is a theme for conversation. Like many other people, Mr. C. A. Whitmore, M.P., is a devoted student of our meteorology, so that what he writes about it in the May number of the *National Review* is worth reading. Weather fallacies have been exposed times without number, but they are so deeply rooted in the minds of the unscientific that it may be doubted whether they will ever be completely eradicated. Mr. Whitmore throws doubt upon the popular impression that the changes of the moon synchronise with marked changes of weather. The few facts he states as to weather and lunar phases since the beginning of last summer, ought to convince people that their faith in the influence of the moon is misplaced. Another very common idea is that a heavy dew at night presages a fine day on the morrow; whereas it only indicates that the sky is clear and conditions are favourable for the deposition of dew. At certain times of the year a heavy dew is a sign of unstable rather than of stable weather. A luxuriant crop of berries in the autumn is said to forebode a severe winter; but the people who believe this, forget, or do not know, that the berries tell of conditions which have passed rather than of those to come. The temperature, sunshine, rainfall, abundance of insects, and other past causes which affect the birth and growth of plants, decide whether the berries shall be few or many, and not the future conditions. It is a beautiful sentiment to think that many berries are provided to furnish food for birds in a hard winter; but, unfortunately, nature does not furnish facts to support it. Having disposed of these and several more items of weather-lore, Mr. Whitmore supplies meteorologists with a few weather signs gained by his own observation and experience.

THE International Aeronautical Committee of Paris and Strassburg have proposed Thursday, May 13, at 3.30 a.m. local time, for the third international balloon ascents. This early hour of sending up unmanned balloons is proposed in order to study the true temperature of the air during the first part of the ascent; while the influence of solar radiation will be from the records obtained during the second part of the time. The results of the experiments of November 14 and February 18, showed that the thermometers were not sufficiently protected in the horizontal part of the trajectory, in which the ventilation is least active; hence it has been deemed necessary to make an important part of the ascent while the radiation of the sun is too weak to have any serious influence upon the thermometric results.

JAPAN is usually regarded as the country of earthquakes; but, if we take area into account, it would seem that shocks are still more numerous in Greece and the adjoining islands. Under the able superintendence of Dr. S. A. Papavasiliou, a geodynamic section of the Observatory of Athens was founded in 1893, and, since the summer of 1895, the seismic organisation of the country has been actively at work. About a year ago, the publication of monthly bulletins was commenced with the number for January 1896, and the number for last December has been issued recently. The notices are nearly always very brief, and it is sometimes uncertain whether they refer to different shocks, or to observations of the same shock at different places. Making allowance for these cases, it would appear that the total number of earthquakes felt in the kingdom during 1896 was 529, or very nearly $1\frac{1}{2}$ a day. Of this number, no fewer than 306 were recorded in the island of Zante alone.

THE property acquired by gases, after being traversed by electric sparks, of cooling heated bodies as if the gases had become better conductors of heat, forms the subject of a short note by Prof. E. Villari (*Rendiconti della R. Accademia di Napoli*). The phenomenon was observed by studying the action of different gases on a platinum spiral heated to redness by the electric current, the sparks being produced by a powerful coil reinforced by large Leyden jars. In some cases, the apparent cooling produced a fall of resistance of 10 per cent. Under similar conditions, the effect was nearly the same for oxygen, nitrogen, and air, but was much less marked in the case of hydrogen. It increases with the energy of the sparks, and also, at first, with the temperature of the spiral; but after this exceeds a certain limit, the refrigerating power decreases. Experiments made with a similar apparatus, with a view of testing whether Röntgen rays modify the thermal conductivity of the gases they traverse, have as yet given negative results.

UNDER the title of "Versuche über Hyperphosphorescenz," Profs. Elster and Geitel publish an interesting note on the invisible radiations from salts of uranium, discovered by Becquerel. The authors confirm Becquerel's statements as to the physical properties of these rays, and the fact, already noted in these columns (vol. xxxv. p. 119), that the salts may be kept in the dark for months without the radiation ceasing, so that the source of radiant energy is at present unknown. Uranium sulphate and sulphate of uranium and potassium are photo-electrically inactive, and the radiation is not materially promoted by sunlight. On the other hand, aluminium, zinc, luminous paint, and fluor spar, when light falls on them, do not, like these salts, emit dark radiations of sufficient intensity to impart electrical conductivity to the surrounding air. The conclusion is, that the present phenomena cannot be attributed to hyperphosphorescence. Profs. Elster and Geitel's paper is published in the *Jahresbericht des Vereins für Naturwissenschaft zu Braunschweig*, No. 10 (Brunswick, 1897).

IN a note in NATURE (December 31, 1896, p. 206) attention was drawn to an essay, by Prof. E. S. Morse, on problematical bronze or iron objects found in Greek, Roman and Etruscan tombs. Prof. D. G. Brinton (*Science*, 1897, p. 614) identifies the so-called "bow-puller" with the Greek myrmex (μύρμηξ) which, in pugilistic encounters, was strapped or chained on the hand over the leathern cestus.

THE large number of interesting Romano-British objects found in Thirst House Cave in Derbyshire, prove that this cave must have been occupied for a long period. It is unfortunate that, as in so many other instances, this important cave should not have been scientifically excavated. Casual cave-digging cannot be too strongly deprecated, as caves afford most valuable data for relative chronology, and it is a pity to have such

important opportunities sometimes wasted by curiosity-hunters. Thirst House is probably derived from "The Hurst House," or the house in the wood. An interesting and illustrated account of the find is given, by J. Ward, in *The Reliquary and Illustrated Archæologist* (1897, p. 87).

F. H. CUSHING, in the *American Anthropologist* (vol. x. p. 17), suggests that the artificial deformation of the skull, like other mutilations of the person, were designed to liken a man either to his totem or to the animal whose distinguishing traits were essential to the office held by the man, and thus to confer through actual physical resemblance ideally conceived animal powers. The evidence Mr. Cushing adduces from America lends some support to this view, which may be an explanation of some, if not of all, the mutilations that have occurred in America. This theory is worth bearing in mind when considering analogous facts in other parts of the world.

THE question of suppressing the rabbit pest in Australia by employing the microbes of chicken cholera for their destruction, has been recently again brought prominently forward by the publication of an able report by the Government bacteriologist, Mr. C. J. Pound. This idea owes its origin, in the first instance, to Pasteur; but one of the principal objections raised at the time to its adoption in New South Wales was the reluctance felt to introduce a new disease, and one hitherto unknown in the Colony. Mr. Pound, however, commences his official document by the announcement that he has discovered the existence of chicken cholera in Queensland and New South Wales; and he describes in detail the various scientific investigations which he has made, placing its identification beyond all question. Experiments on a large scale were carried out last year to test the efficacy of this method of destroying rabbits; and the results were so encouraging, that the Government has been recommended to grant permission to farmers and others, who suffer from the depredations of these animals, to utilise this means of suppressing them. It has been calculated that two gallons of broth infected with chicken-cholera microbes added to pollard, is sufficient to destroy at least 20,000 rabbits, irrespective of infection induced by contagion. As, however, pellets of pollard infected with these microbes are rendered completely innocuous after three hours' exposure to the direct rays of the sun, the distribution of the morbific material over the fields is recommended to take place either just before or after sun-down.

THE Vermont Botanical Club, organised two years ago, now numbers sixty active members. It is vigorously prosecuting a botanical survey of the State.

WE have received the eighth part of vol. i. of the "Records of the Botanical Survey of India," consisting of a note on the botany of the Baluch-Afghan Boundary Commission of 1896, by Mr. F. P. Maynard and Mr. D. Prain.

A SECOND Appendix for 1897 of the *Kew Bulletin of Miscellaneous Information* is devoted to a list of plants brought into cultivation for the first time during the year 1896, or re-introduced after having been lost from cultivation. The list includes over 300 species.

THE recently established New York Botanical Garden is on a very large scale. The buildings, with decorative approaches and surroundings, will cover 25 acres; pines and other coniferous trees, 30 acres; deciduous trees, 70 acres; natural forest, mostly undisturbed, 25 acres; shrubs and small trees, 15 acres; herbaceous ground for scientific arrangement, 8 acres; bog garden, 5 acres; lakes and ponds, 6 acres; meadows, 10 acres. The museum building will have a frontage of 304 feet, with two wings each 200 feet in length.

THERE are several ways of cultivating interest in science, and not the least serviceable of them are works of fiction into which scientific facts and problems are woven. Mr. H. G. Wells commences a new story in the April number of *Pearson's Magazine*, entitled "The War of the Worlds," and its chief idea is an attack which inhabitants of Mars are supposed to make upon the earth. It is evident from many paragraphs that Mr. Wells reads his NATURE, and closely follows the planetary observations described in our astronomical column from time to time.

A NUMBER of our readers will be glad to have their attention called to the advertisement, appearing in another column, of a cruise to the capitals of the Baltic, visiting Christiania, Copenhagen, Stockholm (for the exhibition), and on to St. Petersburg for a seven days' sojourn in Moscow, returning by the Baltic Canal. The cruise is by the Albion Steamship Company's steam yacht *Norse King*, and starts from Newcastle-on-Tyne on May 22, returning on June 19.

THE extensive use of induction coils in surgical and physiological work with Röntgen rays, has created a demand for a practical book which shall show medical men, and others who have entered the new field of experiment, how to make the best use of their instruments. Mr. Lewis Wright, the author of well-known books on experimental optics and optical projection, has prepared a work of this kind, and it will be published in a few days by Messrs. Macmillan and Co. under the title, "The Induction Coil in Practical Work, including Röntgen X-Rays."

AMONG the noteworthy papers and other publications which have come under our notice within the past few days are the following:—The *Comptes rendus* of the works presented at the meetings of the Société Helvétique des Sciences Naturelles, held at Zermatt in 1895, and at Zürich in 1896; also the *Actes* (*Verhandlungen*) of the same meetings. The London agents of these publications are Messrs. Williams and Norgate.—"Le Climat de la Belgique en 1896" (pp. 190), by A. Lancaster. This essay is an excerpt from the *Annuaire* of the Royal Observatory at Brussels for 1897.—The third part of the Report of the International Meteorological Congress held at Chicago in August 1893 (pp. 585-772), edited by Oliver L. Fassig (*Bulletin* No. 11, U.S. Department of Agriculture, Weather Bureau). The report contains twelve papers on climatology, and ten on instruments and methods of investigation. All the papers are in English, and together they make a collection which British meteorologists will highly value.—*Proceedings* of the American Association for the Advancement of Science, for the meeting held at Buffalo in August 1896 (pp. 269). The addresses of the retiring President, Prof. E. W. Morley, and of the Presidents of the different Sections are printed in full, but only the titles of the papers read are given.—*Proceedings and Transactions* of the Nova Scotian Institute of Science, 1895-96. Among the subjects of the papers are the calculation of the conductivity of mixtures of electrolytes, and Nova Scotian undeveloped coal-fields, geology, and Orthoptera.—*Bulletin* of the American Museum of Natural History, vol. viii., 1896 (pp. 327). Several of the articles in this publication have already been noticed in NATURE, from authors' separate papers. Attention may, however, usefully be called to papers on alleged changes of colour in the feathers of birds without moulting, catalogue of meteorites in the American Museum of Natural History, the temple of Tepoztlan, Mexico (illustrated by five plates), descriptions of new North American mammals, notes on birds observed in Yucatan, and transformations of some North American Hawk-Moths.—*Atti della reale Accademia delle scienze fisiche e matematiche di Napoli*, second series, vol. viii., 1897. Eleven memoirs are included in this volume, and among the subjects dealt with are: a class of equations with derived partials, microscopic changes in nerve cells due to functional activity, and under the action of

stimulating and destructive agents; earth currents recorded at the Vesuvius Observatory in 1895, and the history of Vesuvius from 1875 to 1895; a mathematical investigation of the lines of nodes of vibrating membranes; the geology of the Southern Appennines (this elaborate paper occupies 128 pages); the alternate current transformer with a condenser in the secondary circuit; the physical constitution of the atmosphere, from the results of observations made during eight balloon ascents by James Glaisher, also a new formula for the calculation of altitude from barometric observations.—In the *Rendiconti del Reale Istituto Lombardo*, Prof. Luigi de Marchi gives a mathematical investigation of the effect of viscosity on the movements of glaciers.

NOW that acetylene can be readily prepared in the laboratory, many new uses will no doubt be found for it. The most recent proposal in this connection is that made by H. G. Söderbaum, in the current number of the *Berichte*. It appears that the gas can be employed for the quantitative precipitation of copper in ammoniacal solution, and for its separation from metals like zinc, which are not precipitated by ammonia. Acetylene possesses the great advantage over sulphuretted hydrogen, which is usually employed for this purpose, that it yields a precipitate which can be filtered and washed very rapidly, and which does not easily become oxidised and pass into solution. The washed precipitate is finally decomposed by dilute nitric acid, the solution filtered and evaporated to dryness, and the residue ignited and weighed as oxide.

THE additions to the Zoological Society's Gardens during the past week include an Orang-outang (*Simia satyrus*, ♂) from Borneo, presented by Captain Francis R. Pelly, R.N., H.M.S. *Porpoise*; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Mrs. Douglas; a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mr. P. A. Ledger; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, presented by Mr. P. Baxter; a Grey Ichneumon (*Herpestes griseus*) from Ceylon, presented by Surgeon-Major C. Seymour; a Chimpanzee (*Anthropopithecus troglodytes*, ♀), a Black Gallinule (*Limnocorax niger*) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; two Himalaya Goldfinches (*Carduelis caniceps*, ♂ ♀) from India, presented by Mr. Frank Finn; two Egyptian Geese (*Chenalopex ægyptiacus*, ♂ ♀) from Africa, presented by Mr. A. E. Speer; a Mauge's Dasyure (*Dasyurus viverrinus*) from Australia, presented by Mr. J. C. Chipper; a Peacock Pheasant (*Polyplectron chinquis*, ♂) from British Burmah, presented by Mr. Charlton Parr; a Burrhel Wild Sheep (*Ovis burrhel*, ♀) from the Himalayas, a Reed Buck (*Cervicapra arundinum*, ♂) from the Limpopo River, South-east Africa, a Sing-Sing Water Buck (*Cobus unctuosus*, ♂) from West Africa, a Somali Wild Ass (*Equus somilicus*, ♂), a Somali Ostrich (*Struthio molybdophanes*, ♂) from Somaliland, six Pintails (*Dafila acuta*, 3♂, 3♀), European; two Smith's Partridge Bronze-winged Pigeons (*Geophaps smithi*, ♂ ♀) from Australia, two White-headed Woodpeckers (*Leuconerpes candidus*) from Brazil, two Wreathed Hornbills (*Rhytidoceros undulatus*) from Borneo, a Silky Cow Bird (*Molothrus bonariensis*) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

A REMARKABLE RELATION BETWEEN THE DISTANCES, MASSES, AND SURFACE GRAVITIES OF THE PLANETS.—In the *Bulletin Astronomique* for April, M. P. Berthot describes an ingenious empirical law which approximately connects the mean radii (R) of the orbits, the masses (m), and the values of g at the equators of the different planets. By employing a graphical method in which the abscissæ represent the values of gravity (p), and the ordinates those of $\frac{R}{m}$, all the planets, with the exception of Mercury, fall very approximately on an ellipse, $\frac{R}{m}$ being considered negative for all values of p greater or equal to 1, and the unit value of p being that at the surface of the earth.

If $\frac{1}{p}$, instead of p, be used as the abscissæ, the ellipse becomes then an equilateral hyperbola, and if the logarithm of $\frac{1}{p}$ be substituted, the same becomes a parabola. The following table gives the true and calculated values of p for one of the three curves, namely, the ellipse, computed by M. Berthot, those for the hyperbola and parabola showing somewhat greater errors per cent. in the case of Mercury. These latter are not referred to below.

	$\frac{R}{m}$	p (true).	p (calc.) ellipse.	Error for 100.
Mercury ...	6·350	0·439	0·502	14·3
Venus	0·919	0·802	0·803	0·1
Earth	1·000	1·000	1·000	0·0
Mars	14·510	0·376	0·375	0·3
Jupiter ...	0·017	2·261	2·284	1·0
Saturn	0·103	0·892	0·877	1·7
Uranus ...	1·414	0·754	0·764	1·3
Neptune ...	1·824	1·142	1·120	2·0

To make Mercury conform with the values calculated by the above-mentioned formulæ, it is suggested that either the old value of the mass determined by Le Verrier (0·0715) must be adhered to (contrary to more recent investigations), or, if the mass $\frac{1}{9,700,000}$ be retained, the diameter of the planet must be assumed to be one-quarter too large by the phenomenon of irradiation.

THE DOUBLE STAR 44 BOÖTIS.—This star, which was discovered on August 17, 1781, by Herschel, has recently (*Monthly Notices*, vol. lvii. No. 5) been pointed out by Mr. Burnham in consequence of the singular and remarkable arrest of the relative motion of the two stars. For a period of thirty years these stars gradually increased their distance from one another at a nearly uniform rate, the position angle at the same time slowly advancing. After this, for a period of equal length, the motion had apparently been arrested, and "down to the present time, they have remained absolutely at rest, so far as one can tell from full and careful sets of measures by the best double-star observers." This is a remarkable system, which evidently is unique among the known binaries, and, as Mr. Burnham points out, it is not easy to account for such a state of affairs. He remarks, however, that the usual dark-body hypothesis will readily suggest itself; and it is easy to imagine one of these stars with an invisible companion, both moving in a very eccentric orbit in a plane parallel to the line of sight, and to select a period and direction of motion that will not only explain the motion, but the absence of motion shown by the observations of the visible components, and "when this is presented with the usual refinements of computation, doubtless for the time being a plausible case could be made out." It will be interesting to watch this binary, and see, when the relative motion has been resumed and a decided change of position has taken place, whether an accurate, or even approximate, orbit can be obtained. The case is decidedly a unique one for double-star observers; and as there seems to be no question about the observations themselves, the steady change of position and subsequent arrest being based on "unimpeachable observations by the best observers," special interest will be attached to future measurements.

REPORT OF MR. TEBBUTT'S OBSERVATORY.—The energetic proprietor of this observatory presents a most satisfactory report for the year 1896, the amount of work accomplished being unusually large, owing to the very great number of clear nights experienced. The meridian work consisted chiefly in observing stars with the 3-inch transit instrument for checking the sidereal chronometer, which was used as timekeeper throughout the year. The observations of occultations of stars by the moon, made with the 8-inch equatorial, are stated to be the richest obtained in any one year since the foundation of the observatory. Other observations included 810 comparisons of minor planets with the filar micrometer, the phenomena of Jupiter's satellites, double and variable stars, and the regular meteorological work. The report states that all the astronomical and nearly all the meteorological observations were made by Mr. Tebbutt himself,

but during a day's absence from home, about once in three weeks, the meteorological observations were made by his son. In some of the reductions the services of Mr. R. B. Walker were engaged. Quite recently a discussion of the early series of occultation observations made in the years 1864 to 1870 at this observatory, has been concluded by Dr. Hugo Clemens, of Göttingen, in his inaugural dissertation, with a most satisfactory result, which speaks well for the observations employed.

THE TWELFTH GERMAN GEOGRAPHICAL CONGRESS.

THE German "Geographentag," which takes place every second year, was held from April 21 to 23, in Jena. The meeting was attended by over five hundred persons from all parts of Germany, including Prof. Brackebusch, Colonel Frobenius, Prof. Karl Futterer of Karlsruhe, Prof. Gerland of Strassburg, Prof. Hahn of Königsberg, Dr. Hassenstein, Dr. K. Hassert, Herr von Hesse Wartegg, Prof. Kirchhoff of Halle, Captain Kollm (Secretary of the Berlin Geographical Society), Dr. Kretschmer, Count von Linden, Dr. Lindeman, Dr. Hans Mayer, Prof. Neumann of Freiburg, Prof. Neumayer of Hamburg, Dr. Schenck, Prof. Supan of Gotha, Prof. Sievers of Giessen, Prof. Wagner of Göttingen, Prof. Walther of Jena, Prof. Wahnschaffe of Berlin, and Count von Zeppelin. Twelve German Geographical Societies were officially represented, and two foreign Societies—the Royal Geographical Society and the Hungarian Geographical Society—sent delegates.

The town of Jena was decorated for the occasion, and the geographers were warmly received and handsomely entertained. Five meetings were held for the reading and discussion of papers, and each evening there was a social gathering, usually of an informal and genial character.

At the first meeting, after addresses of welcome had been given on behalf of the Grand Duke of Saxe-Weimar, the Municipality of Jena, and the University, the President, Prof. Neumayer, of the German Naval Observatory at Hamburg, delivered a short opening address, and then proceeded to present the Report of the German Committee on South Polar Exploration. He referred in the most generous manner to the approaching Belgian expedition, and to the projected British expedition, under the auspices of the Royal Geographical Society, but urged the importance of a national German undertaking, pointing out that there was scope for many expeditions, simultaneous or consecutive, in the vast unknown areas of the far south. The Committee appointed at the "Geographentag" at Bremen, in 1895, to arrange for a German Antarctic Expedition, had drawn up a comprehensive scheme, but the means with which to carry it out were still wanting. The aims of the expedition were defined as the study of meteorological conditions, terrestrial magnetism, geodesy, zoology, botany, geology, and ice-conditions, as well as geographical exploration. The expedition must, as an essential condition, winter for two years within the Antarctic Circle, while a second vessel carries on hydrographic work on the edge of the ice. The Committee had selected the longitude of Kerguelen Island as the most suitable point for attempting to force a way southward. The co-operation of the observatories in Cape Town, Melbourne, and in Mauritius would give special value to the meteorological and magnetic observations made in the selected part of the Antarctic area. Two vessels of about 400 tons would carry each four officers, four of a scientific staff, and a crew of twenty-two. The whole cost is estimated at under 50,000*l.*, and a strenuous appeal will be made to the German people to subscribe this sum, as soon as the important step of selecting a leader for the expedition has been taken.

The remainder of the first sitting was occupied by papers descriptive of explorations in Brazil by Dr. Hermann Mayer, and in Asia Minor by Dr. Zimmerer and Herr Roman Oberhummer.

The second sitting was devoted, as required by the rules of the Congress, to educational subjects, the most important paper being by Prof. Fischer, on the importance of geographical tours of considerable extent under the guidance of geographical instructors.

The third sitting was devoted to geo-physical questions. Papers on seismic observations were read by Prof. Gerland of Strassburg, and Prof. Supan of Gotha, both of whom dwelt on the urgent importance of establishing systematic seismological observations in all parts of the world. A lively discussion ensued, and Prof. Supan formulated a resolution, which was subsequently adopted, to the effect that the establishment of seismic observations in all countries should no longer be postponed, and that the "Geographentag" hoped that the German Government would take the necessary steps without delay to establish a system of observations in Germany similar to that which had been established and carried out with valuable results in Japan. Dr. Schmidt, of Gotha, read a paper on the geographical problems connected with the study of terrestrial magnetism, and Dr. Naumann, of Munich, spoke of the relation between the magnetic conditions and the geological and geo-tectonic character of a region, illustrating his remarks by reference to his own studies when engaged on the geological survey of Japan.

The fourth sitting was devoted to zoogeography, Dr. Semon, of Jena, discussing the fauna of Australia in the light of his recent researches. Prof. Hahn, of Königsberg, spoke of the distribution of transport animals, and the influence exerted by geographical conditions on the method of transporting goods on land. Dr. Schneider, of Dresden, read a paper on the fauna of the island of Borkum, to which he has devoted ten years of study, and has distinguished an immense number of species and varieties which had not previously been recognised.

At the fifth and concluding sitting, various resolutions arising out of the papers were proposed and voted upon. Breslau was selected as the place of meeting for the thirteenth "Geographentag" in 1899; and Prof. Walther, of Jena, read an important paper on the interpretation of Thuringian scenery by means of the geological structure of the district. He had previously, in the Geological Museum, demonstrated the geology of Thuringia by means of an ingeniously constructed model, which showed the somewhat complicated geological history of the neighbourhood in a strikingly graphic and simple manner.

By special invitation the geographers were shown over the great optical works of Messrs. Zeiss, and had an opportunity of seeing the whole process of the working of lenses and prisms, and the construction of the numerous forms of scientific instruments which are produced in the establishment. Excursions were also made to various places of interest in the neighbourhood, the geology and archæology of which were explained by competent guides.

A word must be said as to the social arrangements, which were of the happiest kind. At the dinner and "Festcommers," given by the town, a number of original geographical songs, composed by Prof. Leo Sachse, were sung, the allusions exciting much amusement amongst the visitors. After the dinner, Usambara coffee and Cameroons cigars were served, as an example of the increasing importance of the German colonies. Altogether the meeting presented an impressive picture of the solid work in scientific geography being carried on in Germany, and of the enthusiasm which professors and students alike bring to bear on the problems they attack.

THE INSTITUTION OF MECHANICAL ENGINEERS.

AN ordinary general meeting of the Institution of Mechanical Engineers was held on Wednesday and Friday evenings, April 28 and 30, the President (Mr. E Windsor Richards) occupying the chair. Two papers were read—the first, on "Mechanical Propulsion on Canals," by Mr. L. S. Robinson; and the second, on "Experiments on Propeller Ventilating Fans and on the Electric Motor Driving them," by Mr. W. G. Walker.

Mr. Robinson's paper was of practical rather than of scientific interest. The most striking point brought out by the author was that it requires no more power to tow a long barge than a short one on a canal, an "enigma," to use an expression Mr. Henry Davy applied during the discussion, which neither the author nor the speakers at the meeting were able to explain. Mr. Robinson was of opinion that the chief point to be observed in canal navigation is the cross section of the canal. Shallow water is fatal to efficiency. This was borne out generally by the speakers during the discussion, Sir Leader Williams stating that it was useless to attempt improvements in mechanical details of tugs, &c., until the waterways were of a design that enable these improvements to be applied with advantage. A description was given of certain experiments made on a hydraulically propelled boat, fitted with a discharge orifice that passed through the stern-post of the vessel, and had a constricted passage, something of the nature of a *vena con-*

tractor, although differing from the latter form to a certain extent. With the discharge orifice of this form a fair speed was obtained, whereas with ordinary discharges the boat could hardly be moved along.

The Rev. Mr. Capell, the originator of this discharge nozzle, gave particulars of the experiment made with the vessel, and concluded that the success of jet propulsion depended on the form of the discharge nozzle. The particulars given were not sufficiently detailed to enable the problem to be adequately discussed, and it would be requisite to know, before arriving at any conclusion, whether the observations taken were properly verified, and the recording instruments were sufficiently trustworthy for implicit reliance to be placed upon them.

Mr. Walker's paper was on an interesting subject, and some of the experiments which he showed were of a practical nature. They will be doubtless useful to those not acquainted with the details of this field of research. The question of relation of speed, power absorbed, and air discharged with propeller ventilating fans was discussed. Seventeen three-bladed fans were tried, being driven by a continuous-current series-wound electrical motor of about one-third electrical horse-power. The current was taken off the mains of the Westminster Electric Supply Corporation. The fans were run at a speed up to six hundred revolutions a minute; the velocity of the air was measured by an anemometer. The results, which are too voluminous to quote in full, were contained in tables attached to the paper. The effect of cross section of fan-blades was discussed in the paper. The blades were of sheet-iron; all, excepting one, of 1/16 inch thick. Their cross sectional lines were all composed of straight lines or arcs of circles. The fans in each group differed from one another only in the cross section of their blades, which were flat, plano-convex, or concavo-convex of different degrees of curvature. A notable feature of the experiments made by the author was that the effect of putting a curved surface upon the back of a flat-bladed fan, thus giving a plano-convex section, was to increase the mechanical efficiency 28 per cent., the volumetric efficiency 54 per cent., and the pressure efficiency 1·4 per cent. The angle of the blades was 17°. The most efficient fan of the group was one having a blade concavo-convex in section with a hollow space between the faces, when the mechanical, volumetric, and pressure efficiencies were respectively 28, 65, and 2·1 per cent. The efficiencies were thus increased by making the blades thicker in the middle of their breadth. To test the effect of feeding the fans from the tips of the blades the delivery tube through which the air was passed was moved forward, the fan thus being outside the tube. This increased the mechanical, volumetric and pressure efficiencies from 16·9, 62·0, and 2·0 to 29·4, 78·0, and 3·1 per cent. respectively. The velocity of air on entering and leaving the fans was measured by the anemometer. Experiments were made to test the effect of a contracted outlet and inlet. The fan worked partly in a delivery tube, the outer end of which was partially closed by plates with holes of varying sizes. The efficiency was naturally much reduced. It was anticipated that the slow speed of the blades near the centre partly accounted for this, and a circular disc was therefore fixed in front of the fan on the delivery side. This prevented the air passing back again through the centre of the fan, which it might do owing to the slow speed, and the efficiency was raised. The more the delivery orifice was closed, the larger had to be the disc.

Without entering into theoretical views as to the action of the blades, the author stated that, having regard to the stream-line principle, the section of the blades should be as ship-shape as possible. The two losses in an air-propeller are rotary motion imparted to the air, and skin friction of the blades. The loss from the latter cause was found to be comparatively small by means of experimenting with flat thin blades set at a plane coinciding with the plane of rotation.

The summer meeting of this Institution will be held this year in Birmingham, during the last week in July.

ANNUAL MEETING OF THE U.S. NATIONAL ACADEMY OF SCIENCES.

THE National Academy of Sciences held its annual meeting at Washington, April 20-22, with about the usual attendance of members, but a marked paucity of papers, only fourteen having been read, of which number five were biographies. These were of Dr. G. Brown Goode, by Prof. S. P. Langley; of Prof. Thomas L. Casey, by Prof. H. L. Abbot: of Prof. Charles E. Brown-Séquard, by Prof. H. P. Bowditch (by title); of Prof. Hubert A. Newton, by Prof. J. W. Gibbs; and of Mr. George H. Cook, by Prof. G. K. Gilbert.

An experimental study on the influence of environment upon the biological processes of the various members of the colon-group of bacilli, by Dr. Adelaide Ward Peckham, was presented by Prof. J. S. Billings.

Prof. T. C. Mendenhall read a paper on the energy involved in recent earthquakes. He also read a paper on a ring pendulum for absolute determinations of gravity, giving results of a suggestion of Mr. A. S. Kimball that a disc of metal vibrating in its own plane would constitute an improved apparatus for such determinations. This gives the equivalent of a pendulum of any length from infinity to that of the diameter of the outer circumference of the ring. The ring is suspended from its inner circumference; and the length of the equivalent pendulum is computed by the following formula, in which l is the length required, R is radius of the outer, and R_2 is that of the inner circle:—

$$l = \frac{R^3 + 3R^2}{R_2}$$

With a crudely prepared disc of this description, results were obtained correct to one part in 10,000.

Prof. S. C. Chandler read a paper on variation of latitude, a full abstract of which will appear in NATURE. He also presented another paper on variation of latitude and constant of aberration from observations at Columbia University, by Messrs. J. K. Rees, H. Jacoby, and H. S. Davis. These observers report a series of observations extending from May 9, 1893, till June 14, 1894, divided into groups of from 30 to 100. They confirm Chandler's period of about 427 days. They also fix accurately the latitude of the observatory of Columbia University, which is 40° 48′ 27″·195.

Prof. A. A. Michelson gave a description of a new harmonic analyser, an apparatus devised by him, which enables him to integrate in a few minutes long and difficult problems such as would require weeks for mathematical solution.

In his paper on the position of the Tarsiids and relationship to the phylogeny of man, Prof. Theodore Gill maintained that man is more nearly allied to the chimpanzee and the gorilla than to the orang-outang; the abbreviation of arms and loss of cranial ridges having been caused by disuse of arms for tree climbing, and of teeth for crushing branches, &c., so that powerful facial muscles were no longer required, nor the ridges to which they were attached. The teeth also approached more closely together, filling up the gaps in jaw of apes. Children still show ancestral type in disproportionate length of arm.

Prof. A. Agassiz read a paper on some recent borings in coral reefs, in which he maintains that the old Darwinian theory of subsidence is no longer tenable, as that would require a thickness of 2000 feet in such reefs, but in most cases examined the thickness was within 130 feet. Observations include the Yucatan atoll, about 30 fathoms; Solomon Islands, 125 to 130 feet; Florida elevated reef, 60 feet, but this has been denuded and may have been originally of twice this thickness; along the coast of Cuba, 145 feet. Prof. Agassiz attempted to measure the thickness of the great coral reef near Australia, which is 1500 miles long, and 50 to 75 miles wide; but could not yet obtain accurate results. He is confident, however, that the thickness of it is only 25 to 30 fathoms. Prof. Agassiz concludes, however, that barrier, fringing and atoll reefs are none of them thick.

Prof. A. W. Wright read a paper on some recent experiments in Röntgen rays. By using plane glass he obviates the misleading action of a prism in which the thick part absorbs rays, and indicates an apparent negative index of refraction. No indication of refraction was found, however, in using plane glass arranged at an angle so that it would refract rays of light. A thin beam of X-rays was also passed between the poles of a powerful magnet. The poles were then reversed, but no change in the direction of the rays could be detected. Some very recent experiments, however, which he has not yet fully verified, seem to show that perhaps these rays may be diffracted, even if not capable of being refracted. The conjecture is due to the fact that, on passing the beam through a platinum net-work in the manner described, faint interference lines seemed to be produced.

Prof. Asaph Hall was elected vice-president; Prof. Ira Remsen, home secretary; and Prof. A. Graham Bell, treasurer. New members elected were Messrs. Wm. H. Dall (of Washington); Frank A. Gooch (of Yale); Chas. S. Minot (of Boston); and E. W. Morley (of Cleveland).

The autumn meeting of the Academy will be held at Boston on November 16 next.

CONTINUATION OF EXPERIMENTS ON ELECTRIC PROPERTIES OF URANIUM.[1]

IN a paper read before the Society on March 1, we had the honour to communicate some preliminary results on the electric properties of uranium. We propose now to give other results on the same subject, bearing on the conductance induced in air by uranium.

To measure the leakage in air at ordinary pressure at different voltages, we used in our first experiments the two-Leydens method described in a former paper. We found that the leakage was not proportional to the electro-motive force. It was not perceptibly increased when the uranium was heated, or when the sunlight fell on it.

We also observed the leakage in hydrogen, oxygen, and carbonic acid. The experimental arrangements necessary for this are described in a paper published by the Royal Society of Edinburgh. We found that the rate of leakage is greater in oxygen than in air. The ratio of the rates depends on the voltage chosen. The leakage in hydrogen is less than in air. In carbonic acid it is less for four volts per two cms., but greater for ninety volts per two cms. than it is in air; for the latter voltage the leakage in carbonic acid is greater even than the corresponding leakage for oxygen at ordinary pressure. We also made experiments with air, hydrogen, oxygen, and carbonic acid at different atmospheric pressures. We found that the leakage in air at pressures ranging from 760 mms. to 23 mms. was very nearly proportional to the atmospheric pressure. The rate of leakage for lower pressures was so slow as to make the results not very trustworthy. At pressures under 2 cms. no appreciable leakage with 4 or with 90 volts per two cms. was observed. With hydrogen, oxygen, and carbonic acid the rate of leakage at higher pressures was somewhat approximately proportional to the pressure, at lower ones to the square root of the pressure.

We found that at ordinary atmospheric pressure, sparking took place in air at 4800 volts, between a rough fragment of uranium and a metal tube around it, connected to the two electrodes of a vacuum-tube within which they were fixed. At 232 mms. pressure, the potential necessary to produce a spark fell to between 1500 and 2000 volts. At 127 mms. it had fallen to between 1100 and 1300 volts. At 54 mms. it was 700 volts; at 7 mms. 420 volts; at 2 mms. about 400 volts. At 1/1000 mm. the voltage necessary to produce sparking rose again to 2000 volts.

To measure the potential difference between two mutually insulated metals when the air between them is rendered conductive by the presence of uranium, we used two methods, which are described more particularly in the paper above referred to. The steady reading obtained when the quadrants of an electrometer were in metallic connection we shall call the metallic-zero. The deviation from the metallic-zero, when the quadrants were insulated, to a steady point—the uranium-conductance-zero, as we shall call it—depended on the volta difference between the two opposed surfaces of metals, more or less tarnished as they generally were. This deviation took place gradually in about half a minute with one arrangement of apparatus, and in about four minutes with a second arrangement. On the other hand, if the insulated metal had a charge given to it of such an amount as to cause the electrometer reading to deviate from the metallic zero beyond the uranium-conductance-zero, the reading quickly fell to this conductance-zero, and there remained steady.

The following table gives the potential differences between the electrometer wires, when one of them is connected with uranium, and the other with a plate of one or other of the named metals opposed to it:—

[1] By Lord Kelvin, Dr. J. Carruthers Beattie, and Dr. M. S. de Smolan. Read before the Royal Society of Edinburgh, April 4.

Metal.	Volt.
Polished aluminium (1) immediately after being polished	– 1·13
Polished aluminium (1) next day	– 0·90
Polished aluminium (2)	– 1·00
Amalgamated zinc	– 0·80
Polished zinc	– 0·71
Unpolished zinc	– 0·55
Polished lead...	– 0·54
Tinfoil	– 0·49
Unpolished alumininum (1)	– 0·41
Polished copper	– 0·17
Silver coin	+ 0·05
Unpolished copper	+ 0·07
Carbon	+ 0·20
Oxidised copper (*a*)	+ 0·42
Oxidised copper (*b*)	+ 0·90

It will be noticed that the difference of potential observed depends very much on the state of polish of the metal concerned. With a third specimen of oxidised copper a potential difference of + 0·35 of a volt was obtained. This specimen was afterwards connected to sheaths; a piece of polished aluminium was placed opposite it, and connected to the insulated terminal of the electrometer. The uranium disc, insulated on paraffin, was then placed between them, and the deviation observed was equivalent to a potential difference of – 1·53 volts; that is, we obtained an effect equivalent to the sum of the effects we had when the metals were separately insulated in air opposite to uranium.

We observed also the effect of various screens on the rate of reaching the conductance-zero. For example, when a sheet of lead about 2 mms. in thickness was used as screen, no deviation from the metallic-zero was obtained. In other words, lead 2 mms. thick is not transparent to the uranium influence. Glass 3 mms. thick did not entirely stop the deviation; it reduced the deviation in the first minute, however, to $\frac{1}{4}$ of the amount obtained with no screen. A copper screen, 0·24 mm. in thickness, reduced the rate to $\frac{1}{3}$; two copper screens, total thickness 0·48 mm., reduced it to $\frac{1}{12}$; three copper screens, 0·72 mm., reduced it to $\frac{1}{40}$. A mica screen did not reduce the rate at all. A zinc screen, 0·235 mm. thick, reduced it to $\frac{1}{2}$. Two zinc screens, total thickness 0·47 mm., reduced it to $\frac{1}{7}$. Paraffin, 3 mms. thick, when placed between the two mutually insulated metals, stopped the deviation from the metallic to the conductance-zero.

The final difference of potential observed between the electrometer wires connected to two mutually insulated metals, when the air between them was made conductive by uranium, was found to be independent of the distance between the metals through distances ranging from less than $\frac{1}{2}$ cm. to 8 cms.

The difference of potential observed when two mutually insulated metals were brought into electric connection with one another by a drop of water, was in the same direction as the uranium conductance-zero between the two surfaces when dry, and was smaller in magnitude. On the other hand, when the uranium surface was covered with water to the depth of about a millimetre, and an air space left above the water, between the submerged uranium surface and the opposed insulated metal, so that we had uranium-water-air-metal, the rate of deviation from the metallic-zero was reduced so much as to be scarcely observable.

We found that the uranium-conductance-zero between zinc and uranium was the same in air, hydrogen, and oxygen. And that the final steady reading did not depend on the atmospheric pressure, though the rate at which this steady reading was reached did largely depend on the atmospheric pressure.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Nansen has made a contribution of £50 towards the teaching of Geography in the University.

The voting of the Senate on the resolutions respecting degrees for women will take place from 1 to 3 p.m. on Friday, May 21, in the Senate House.

The University of Madras is to be added to the list of Indian Universities which are affiliated to the University of Cambridge.

On account of the incidence of the Jubilee celebrations, the degree days at the end of this term are displaced to June 18 and 19.

THE Universities of Edinburgh and Glasgow each receive the sum of 5000*l*. by the will of the late Miss Brown, of Waterhaughs, Ayrshire. Miss C. Trow has left a bequest of 2000*l*. to found a scholarship, to be called the "Thomas Trow Scholarship," in St. Andrews University.

AT a recent meeting of the Governors of McGill University, it was resolved to institute forthwith a chair of Zoology in the University, the Chancellor, Sir Donald A. Smith, generously undertaking to defray the expenses of the foundation. With the sister department of Botany suitably equipped and provided for, it will be possible to make considerable advances along the lines of biological research and investigation.

THE *Lancet* states that at the statutory half-yearly meeting of the General Council of Edinburgh University, held last week, the draft ordinance issued by the Universities Commission instituting a "Professorship of Public Health and Sanitary Science (to be called the Bruce and John Usher chair of Public Health)" was approved. The professor of this new chair is to have a salary of not less than 600*l*. Mr. A. L. Bruce's bequest was "in acknowledgment of Pasteur's investigations."

THE March *Journal* of the South-Eastern Agricultural College, Wye, does credit to that young and vigorous institution, and to the County Councils of Kent and Surrey. Mr. F. V. Theobald contributes a number of instructive notes on injurious insects; and there are in the *Journal* several papers which should prove of great value to hop-growers, one, by Mr. John Percival, on the hourly temperatures of hops from the beginning to the completion of an oasting, being of special importance.

THE following are among recent appointments:—Dr. Beckenkamp to be professor of mineralogy at Würzburg; Prof. L. Claisen, of Aix, to be professor of chemistry at Kiel; Dr. Gaupp to be an assistant professor of anatomy in the University of Freiburg; Dr. E. H. Loomis, instructor of physics in Princeton University, to be assistant professor of physics in the same University; Dr. Friedrich Gräfe to be associate professor of mathematics in the Technical High School at Darmstadt; Dr. E. Fischer, associate professor of botany at Berne, to be professor and director of the botanical gardens in that place; Dr. P. Francotte to be professor of embryology at Brussels, and Dr. P. Stroobant to be professor of astronomy at the same place.

WE have received a copy of a memorandum drawn up by Dr. R. W. Stewart, principal of the Hartley Institution, Southampton, on behalf of the Hartley Council, and sent to the Chancellor of the Exchequer. The memorandum urges the claims of the Hartley Institution to a share of the increased grant which it is proposed to give to the University Colleges of Great Britain. That the Institution is doing valuable educational work must be acknowledged, but, judging from the memorandum, it attempts too much. We also venture to say that our University Colleges stand on a somewhat higher educational plane than the Hartley Institution, in spite of Dr. Stewart's reorganisation of the work, and the appointment of a "professional" staff. Certainly, if the application is considered, some of our best technical colleges will be justified in lodging a similar claim.

MR. J. PASSMORE EDWARDS' contributions to the streams which give life and strength to the physical and mental character of many sections of the community are so numerous, that they are almost past counting. We may be permitted to regret that but a minor rivulet having Mr. Passmore Edwards' generosity as a source flows through the field of scientific investigation, but at the same time we are glad that the growth and extension of education has been encouraged by a constant flow of gifts. How well Mr. Passmore Edwards has ministered to the general advancement of the people, may be seen from a recent publication containing illustrations of institutional buildings for educational and ameliorative purposes provided by him in response to public requests, and which will be completed or commenced during this year of the Jubilee. The buildings, twenty-five in all, constitute a most worthy contribution to the stream of individual and organised endeavour made during a notable year of a notable reign for the general good. Ten of the institutions illustrated are public libraries; two are public libraries and technical schools combined; and three will be devoted exclusively to artistic, scientific and industrial education; while all have been, or are being, built with funds provided by Mr. Passmore Edwards. When it is remembered that these do not include buildings of a similar character erected by the same donor before the commencement of the Diamond Jubilee year, a faint idea may be obtained of the valuable support he has given to educational agencies.

THE Report of the Council of the City and Guilds of London Institute upon the work of the Institute during 1896, may be taken as a complete reply to the few short-sighted people who, about this time last year, wished to see whether the results attained could be expressed in pounds, shillings and pence. In the Central College, and the Technical College, Finsbury, the Institute possesses establishments which show the way to improve technical education in this country. At the opening of the former College, the late Lord Selborne stated that "in the several laboratories with which this College is provided new and increased facilities will be afforded for the prosecution of original research, having for its object the more thorough training of the students, and the elucidation of the theory of industrial processes." As a supplement to the education which a student should receive at a college in the technical applications of science, Prof. W. E. Ayrton, the Dean of the College, points out that the experience which the student gains by carrying out a research is of great value in teaching him to think for himself, and acquire habits of self-reliance. Further, his having to adopt expedients for overcoming the experimental difficulties which are met with in all original researches trains his ingenuity, and this is necessarily of great value to one who is about to become an engineer, and who may, therefore, be brought face to face with totally new problems in practical life. The long list of investigations carried out in the various laboratories during the Sessions 1893-96, shows that this prosecution of original research has been carefully kept in view.—Dr. Sydney Williamson, who now holds the Salters' Company Research Fellowship at the College, has selected as his subject of investigation food stuffs generally, and more particularly some of the more definite albumenoids, with the ultimate object of ascertaining the influence of various manures on the growth of crops in so far as quality of produce is concerned. The subject is one of which we know practically nothing, and is obviously of great economic importance.

SCIENTIFIC SERIALS.

American Journal of Science, April.—Experimental investigation of the equilibrium of the forces acting in the flotation of discs and rings of metal; leading to measures of surface tension, by A. M. Mayer. The author describes a number of experiments on the flotation of clean ungreased wires on water. By observing the weight required to make them break through the water surface, a good value for the surface tension of water may be obtained. It is a mistake to suppose that a wire ring will not float unless it is greased. A ring of 1 mm. aluminium wire 5 cm. in diameter will make a depression of 5 mm. in a clean water surface, and requires 2·6 grams to make it break through. The value of the surface tension of water at 0° obtained by the author is 0·0809, which is $3\frac{1}{2}$ per cent. higher than the mean of all determinations hitherto made.—Note on computing diffusion, by G. F. Becker. Introduces a simplified method of treating diffusion of substances in solvents and of heat in rocks, for the use of geologists, together with skeleton tables for the rapid computation of diffusions.—The application of iodic acid to the analysis of iodides, by F. A. Gooch and C. F. Walker. Iodic acid is easily and completely reduced by an excess of hydriodic acid with the liberation of iodine according to the equation: $HIO_3 + 5HI = 6I + 3H_2O$. The authors work out a method for the quantitative estimation of iodides, dependent upon the action of iodic acid or an iodate in the presence of free sulphuric acid, neutralisation of the solution by means of an acid carbonate, and titration of the free iodine by arsenious acid, five-sixths of the iodine thus found being credited to the iodide to be estimated. In the absence of large amounts of chlorides or bromides, the method is simple, rapid, and fairly accurate.—Difference in the climate of the Greenland and American sides of Davis and Baffin's Bay, by R. S. Tarr. The climate of

Greenland is milder than that of Baffin's land, partly owing to a warm current which skirts the land northward as far as Melville Bay, and partly owing to a difference in the prevalent winds. Greenland is being depressed, probably owing to an accumulation of ice, which is now being taken off from the glaciers where they enter the sea. The American side is rising north of Labrador.—Temperature and ohmic resistance of gases during the oscillatory electric discharge, by J. Trowbridge and T. W. Richards. Although a vacuum tube will offer a resistance of several thousand ohms to a continuous discharge, its resistance to an oscillatory discharge may not exceed ten or twenty ohms, as shown by the feeble damping impressed upon the discharge. The latter is determined by spark photographs, and by finding what wire resistance will produce the same amount of damping.—Does a vacuum conduct electricity? by John Trowbridge. It does.—The affinities of Hesperornis, by O. C. Marsh. Points out that his characterisation of Hesperornis as a "swimming ostrich" in 1872, has since been verified (see NATURE, vol. lv. p. 534).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 8.—"Double (Antidrome) Conduction in the Central Nervous System." By C. S. Sherrington, M.A., M.D., F.R.S., Holt Professor of Physiology, University College, Liverpool. Received Februaiy 15.

In a paper presented to the Society last year, I drew attention to the fact that if, after transection over the bulbospinal axis, the *funiculus gracilis* be excited, at the *calamus scriptorius*, the excitation evokes movement (contraction, relaxation) in the idiolateral hind limb. If instead of *f. gracilis* the *funiculus cuneatus* be excited, the movement (contraction, relaxation) is in the idiolateral fore limb. The movement in the hind limb is in the monkey usually adduction and flexion of hallux, in the cat flexion of knee, hip, or ankle. In the monkey the fore limb movement is usually flexion and adduction of pollex, often with extension of the other digits; in the cat, more usually flexion of elbow with protraction of the shoulder. The movements which occur are, however, various, and I will here only add that those from the *f. gracilis* include the vaginal and anal orifices, the tail, and the abdominal muscles, those from *f. cuneatus* the diaphragm; but that neither from *f. gracilis* nor *f. cuneatus* have I obtained idiolateral extension of elbow or of knee.

The reaction is obtainable when the transection has been made altogether below the *nuclei graciles et cuneati*. It therefore does not necessarily involve the cells of those nuclei.

The reaction from the left *f. gracilis* is annulled by severance of the left dorsal column, that of the right by the severance of the right.

What, then, is the nature of this reaction obtainable from the *f. graciles* and *cuneati*? The reaction is evidently one which involves each dorsal column of the cord as a conducting path, in many cases even employing its whole length. In light of the evidence given above, I infer that although certainly, as has been long established, the dorsal column is, with the single exception of its short, scanty, and deeply-placed ground-bundle, a functionally pure *upward* path, consisting of nothing else than sensory root fibres, the vast majority of which—and the entirety of the longest of which—are ascendant; the conduction along it in these experiments is *downward*, even extending its whole length. That is to say, the conduction must be downward and cellulipetal along ascending axons which function in a cellulifugal direction; that is to say, the propagation of the impulses artificially started in my observations must have been *antidrome* instead of *orthodrome*. The motor discharges evoked I refer to the spread of the excited condition into the collaterals of the axons excited to antidrome conduction, their collaterals impinging upon motor neurons.

The direction of propagation occurs therefore in opposition to the law of the "*polarisation dynamique des nevrons*" put forward by Ramon y-Cajal and V. Gehuchten. It offers, however, no contradiction to what James has termed "the law of forward direction"; it only emphasises that that law predicates the existence of at least two links in its conduction-gear.

The reaction is therefore, in my view, an extreme illustration of double (antidrome, *doppelsinnige*) nervous conduction. After du Bois' fundamental observation with frog's sciatic and the electrical sign, it has been Kühne's *sartorius* experiment, and Babuchin's reversed discharge in the electric organ nerve-fibre, which have laid a satisfactory foundation for double conduction in peripheral nerves. But between those experiments and these, the subject of this note, there are, it is true, differences. In the latter, (α) propagation occurs over relatively huge distances and (β) the reaction occurs within the field of the central nervous system. These differences need not, however, negative the relationship of the phenomena. They render it the more instructive.

It is obvious that there must be opportunity for detection of antidrome conduction in parts of the central nervous system besides the dorsal spinal columns. Thus, on exciting, especially with electric currents, the mammalian metencephalon (*vermis cerebelli*) and *isthmus rhombencephali*, subsequent to ablation of the parts above, I have seen movements produced in the limbs and trunk, and also inhibitions occur. Thus, in instance of the latter, inhibition of the tonic extensor spasm of the fore and hind limbs combined with contraction of the flexors of knee and elbow, such as is seen under local spinal reflex action. It will have to be determined whether in such cases as the former we have not before us instances of antidrome conduction along ascending paths. The antidrome phenomenon, while of valuable assistance when recognised, may, if unrecognised, give rise to very misleading inferences. Its methodic use should place in our hands a fresh instrument of value for neurological research.

"On the Breaking-up of Fat in the Alimentary Canal under Normal Circumstances and in the Absence of the Pancreas." By Vaughan Harley, M.D., M.R.C.P., Professor of Pathological Chemistry, University College, London. Received March 18.

In this paper the author, after stating the results of his previous experiments, in which he found that from 21 to 46 per cent. of the total fat given in a milk diet was absorbed from the alimentary canal in the space of seven hours in normal dogs, found that in those dogs in which the pancreas had been entirely removed two days previously, no evidence of any absorption could be obtained during the same time.

The fact that no marked absorption of fat occurred in dogs after the extirpation of the pancreas, seems to confirm the old view that the pancreatic secretion was necessary for absorption.

This alleged action of the pancreatic juice in preparing fat for its absorption, is usually supposed to be due to the fat-splitting ferment and the alkaline sodium carbonate, which combines to form soaps with the free fatty acids.

In the author's paper he investigated whether, after the removal of the pancreas, fat continued to be broken up in the alimentary canal. For this purpose animals were fed on milk, and seven hours later the contents of the stomach, small intestines, and large intestines were separately analysed with regard to the quantity of neutral fat, free fat acids, and fat acids as soaps.

As far as the stomach is concerned, the quantity of fat acids was increased in the dogs in which the pancreas had been removed. It seems that this increase is probably due not to a greater splitting-up action of the fat, but to the longer retention of the fat in the stomach; for after the pancreas is removed, the motility of the stomach is much diminished.

Soaps also were formed both in the normal and pathological dogs, so that both in the normal dogs as well as in those in which the pancreas had been removed, the stomach is capable not only of splitting up neutral fat into free fat acids and glycerine, but that, further, they are capable of finding an alkaline substance with which they can form soaps even in the acid stomach contents.

The power of the free fatty acids for forming soaps is, however, extremely limited in the stomach. In normal dogs the principal fat-splitting action really begins not in the stomach, but after it has left the pylorus.

The normal dogs contain no less than 72·22 per cent. of the total fat as free fat acids, while, when the pancreas had been entirely removed, no less than 61·62 per cent. of the total fat was thus present. There can be no doubt, therefore, that even where no pancreatic secretion has reached the intestines, a very considerable quantity of neutral fat is split up into free fat acids in the small intestine, although the quantity there formed is not

so great as when the pancreatic secretion has been able to share in the work.

The formation of soap is also carried on as in the normal dogs.

In the contents of the large intestine, the normal dogs, and those in which the pancreas had been previously removed, for all practical purposes showed an equal breaking-up of the neutral fat.

Linnean Society, April 15.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. H. Fisher, the naturalist attached to the Jackson-Harmsworth Polar Expedition, gave some preliminary observations on the plants collected by him during his two years' residence in Franz-Josef Land.—On behalf of Mr. A. O. Walker, an abstract was read of a paper on some new Crustacea from the Irish Seas. Of the four species of Edriophthalma described as new, two of them, viz. *Leuconopsis ensifer* and *Stenothoë crassicornis*, were taken, at a depth of 33 and 23 fathoms respectively, during the dredging and trawling operations of the Liverpool Marine Biological Committee, in April 1896. Of the other two novelties, *Apseudes hibernicus* was taken by Mr. Gamble between tide-marks during a week's collecting at Valentia Harbour; and *Parapleustes latipes* was found by Mr. Walker, while naming the collection of Amphipoda in the Dublin Museum of Science and Art. Four specimens were taken in 750 fathoms off the south-west coast of Ireland.—The Secretary gave an abstract of a paper by Dr. A. J. Ewart, on the evolution of oxygen from coloured bacteria. The author found that coloured bacteria, under certain appropriate conditions, possess the power of evolving oxygen in greater or less amount. In some the oxygen appeared to be absorbed from the air by the pigment substance excreted by the bacteria. The process, he considered, was not a vital one. The substances contained in an alcoholic extract were found to have the same power, though less marked, of occluding oxygen; but this property was soon lost. The purple and green bacteria, in which the pigment forms an integral part of the bacterial plasma, when exposed to radiant energy showed a very weak evolution of oxygen, continuing for an indefinite period under favourable conditions. In the former of these the assimilatory "pigment" is "bacterio-purpurin," in the latter "chlorophyll." The process in this case is a vital one, and the oxygen evolved is apparently derived from the assimilation of carbon dioxide.

Zoological Society, April 29.—Sixty-eighth Anniversary Meeting.—In the absence of the President, the chair was taken by Dr. Edward Hamilton, Vice-President. After the auditors' report had been read and a vote of thanks accorded to them, and some other preliminary business had been transacted, the report of the Council on the proceedings of the Society during the past year was read by Dr. P. L. Sclater, F.R.S., the Secretary. The total receipts of the Society for 1896 had amounted to 27,081*l*. 10*s*. 4*d*. The ordinary expenditure in 1896 had amounted to 23,788*l*. 1*s*. 2*d*. Besides this, a sum of 2617*l*. 15*s*. had been paid and charged to extraordinary expenditure, of which amount 2600*l*. had been paid on account of the construction of the new house for ostriches and cranes. A further sum of 1000*l*. had also been transferred to the deposit account, leaving a balance of 1066*l*. 15*s*. 4*d*. to be carried forward for the benefit of the present year. The number of visitors to the Gardens in 1896 was 665,004. The number of animals in the Society's Gardens on December 31 last was 2473, of which 902 were mammals, 1132 birds, and 439 reptiles and batrachians. Amongst the additions made during the past year eighteen were specially commented upon as of remarkable interest, and in most cases new to the Society's collection. Amongst these were a young male manatee, from the Upper Amazons; a young male klipspringer, from North-east Africa; a young female gorilla, from French Congoland; a pair of lettered aracaris, from Pára; a young Brazza's monkey, from French Congoland; a Loder's gazelle, from the Western Desert of Egypt; three ivory gulls, from Spitzbergen; and three Franklin's gulls, from America. The report having been adopted, the meeting proceeded to elect the new members of Council and the officers for the ensuing year. The usual ballot having been taken, it was announced that William Bateson, F.R.S., Colonel John Biddulph, Dr. Albert Günther, F.R.S., Osbert Salvin, F.R.S., and Joseph Travers Smith had been elected into the Council in the place of the retiring members, and that Sir William H. Flower, K.C.B., F.R.S., had been re-elected President, Charles Drummond, Treasurer, and Dr. Philip Lutley Sclater, F.R.S., Secretary to the Society for the ensuing year.

PARIS.

Academy of Sciences, April 26.—M. A. Chatin in the chair.—On the Inseminеæ with two integuments, forming the subdivision of the Bitegmineæ, by M. Ph. van Tieghem.—Researches on the composition of wheat, and on its analyses, by M. Aimé Gerard. The chemical analysis should in all cases be preceded by a mechanical separation of the different parts of the grain, approximating to the process of milling, if the analysis is to be of any service to the baker. For baking purposes it is not sufficient to determine the total gluten only, but this must be supplemented by finding the ratio of glutenine to gliadine.—On the immunity of the fowl against human tuberculosis, by MM. Lannelongue and Achard. The effects produced on fowls and pigeons by inoculation with tubercle bacilli, appear to be the same whether the organisms are alive or dead. But although the bacilli appear to lose their power of spreading, they remain alive and virulent in the local lesion, the blood of the fowl not containing any substance capable of destroying, or even interfering with the growth of the bacilli.—Influence of surfusion on the freezing point of solutions of sodium chloride and alcohol, by M. Raoult. The relation between the true lowering of the freezing point, C, the observed lowering, C^1, and the surfusion, S, is given by $C = C^1 (1 - KS)$, where K is a constant. It follows that for the same surfusion, with the same instrument and method of working, the ratio C/C^1 is constant, and that the error due to surfusion is without effect upon the meaning of the results. Experiments are given for aqueous solutions of sodium chloride and of alcohol, six concentrations of each. The results are in accordance with the theory of Arrhénius.—Monograph of the quaternary fossils of Algeria, by M. A. Pomel.—Memoir on a method for the rapid determination of distances, by M. N. Ursalovitch.—On the theory of flying, by M. Chantron.—Remarks by M. Bouquet de la Grye on presenting the results of the triangulation of Corsica.—On the electric properties of the radiations emitted by bodies under the influence of light, by M. Gustave Le Bon. Some experiments are quoted, which show that the criticism of previous results, based upon the supposed transparency of the ebonite plate used, was unfounded. Substances under the action of light emit rays which cause the discharge of electrified bodies, the rapidity of discharge varying with the nature of the substance. This action has already been shown for uranium by M. Becquerel, which appears to be only a particular case of a general law.—The thermoluminescence caused by the rays of M. Röntgen and M. Becquerel, by M. J. J. Borgman.—On the biphosphide of silver, by M. A. Granger. Reduced silver kept in an atmosphere of phosphorus at 400° is slowly transformed into a definite phosphide, AgP_2, which is decomposed again at 500°, so that silver, like gold, presents the peculiarity of absorbing phosphorus at 400°, giving it up again at 500°, and retaining it again at 900°.—On nitrosomethyl-diphenylamine, by M. Ch. Cloëz. All attempts to prepare a dinitrosomethyl-diphenylamine were fruitless, the mono-nitroso-derivative being always obtained. The amine being a very feeble base, for a good yield an excess of concentrated hydrochloric acid is necessary, and the mixture must be well cooled.—New Coccidia in the digestive canal of Myriapods, by M. Louis Leger. One of these is found in the digestive tube of *Lithobius impressus*, where it is so numerous that during six days the excrements were almost entirely composed of hundreds of cysts of this Coccidium. It appears to be allied to the genus *Barroussia* (A. Schneider), but is clearly distinguished from the *B. ornata* of Nèpe, by the form of the cyst and spores. The second is found in several species of *Lithobius*, especially *L. castaneus*, *L. forcipatus*, and *L. Martini*, and is identical with the genus *Bananella* of M. Labbé.—On a supposed disease of truffles caused by worms, by M. Joannes Chatin. The worms observed in truffles are simple saprophytes, offering no danger to man.—On the nutritive apparatus of *Cladochytrium pulposum*, by M. Paul Vuillemin. The nutritive apparatus of this parasite is a naked granular protoplasmic mass, containing numerous rings and bundles of striated muscular fibrillæ. It acts upon the cellulose membranes.—The radical cure of hernia by injections of chloride of zinc, by M. Demars. A description of six cases, all of which were cured, apparently permanently, by the above method.—

Note on the preceding communication, by M. Lannelongue.—On the locomotive action of the anterior members of the horse, by M. P. Le Hello. As a result of the photographic study of the horse in motion, mechanical apparatus has been constructed demonstrating the muscular actions.—The action of the sun and the moon upon the atmosphere, and on the anomalies of the pressure, by M. P. Garrigou-Lagrange.

DIARY OF SOCIETIES.

THURSDAY, MAY 6.

ROYAL INSTITUTION, at 3.—Liquid Air as an Agent of Research: Prof. J. Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Kafiristan: its Manners and Customs: Sir George Scott Robertson, K.C.S.I.

LINNEAN SOCIETY, at 8.—On Desmids from Singapore: W. and G. S. West.—The Problem of Utility: Captain W. F. Hutton, F.R.S.—On New Species of Mollusca from the Island of Madeira: Rev. R. Boog Watson.

CHEMICAL SOCIETY, at 8.—A Bunsen Burner for Acetylene: A. E. Munby.—On the Reactions between Lead and the Oxides of Sulphur: H. C. Jenkins and A. E. Smith.—Ballot for Election of Fellows.

GRESHAM COLLEGE (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

FRIDAY, MAY 7.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Experiments on Propeller Ventilating Fans, and on the Electric Motor driving them: William G. Walker.

GEOLOGISTS' ASSOCIATION, at 8.—Coral Islands: W. W. Watts.

GRESHAM COLLEGE (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

SATURDAY, MAY 8.

ROYAL BOTANIC SOCIETY, at 4.

GEOLOGISTS' ASSOCIATION—Excursion to Southborough and Tunbridge Wells. Director: G. Abbott. Leave Charing Cross Station (S.E.R.) 9.22 a.m.; arrive Southborough 10.50 a.m.

LONDON GEOLOGICAL FIELD CLASS.—Excursion to Caterham to Redhill, *viâ* Godstone. Upper Greensand. Leave Cannon Street 2.17; arrive Caterham 3.12.

MONDAY, MAY 10.

SOCIETY OF ARTS, at 8.—Design in Lettering: Lewis Foreman Day.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Recent Journeys in Sze-Chuan, Western China: Mrs. Bishop.

TUESDAY, MAY 11.

ROYAL INSTITUTION, at 3.—Volcanoes: Dr. Tempest Anderson.

ROYAL HORTICULTURAL SOCIETY, at 1.—Diseases of Plants.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Lantern Demonstration on the Anthropological Features of the External Ear: Dr. A. Keith.—*Probable* Papers: A Quinary System of Notation used in Luchoo: Prof. Basil Hall Chamberlain.—Ancient Measures in Prehistoric Monuments: A. L. Lewis.—Rock Paintings and Carvings of Australian Aborigines: R. H. Mathews.

IRON AND STEEL INSTITUTE, at 10.30.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Portraiture: Harold Baker.—Mr. Rogers, of Watford, will show his Acetylene Burner for Portraiture.

ROYAL VICTORIA HALL, at 8.30.—More about Röntgen and other Rays: Prof. A. W. Porter.

WEDNESDAY, MAY 12.

SOCIETY OF ARTS, at 8.—Motor Traffic: Technic Considerations: Sir David Salomons, Bart.

GEOLOGICAL SOCIETY, at 8.—The Gravels and Associated Deposits at Newbury (Berks): E. P. Richards.—The Mollusca of the Chalk Rock, Part II.: Henry Woods.

IRON AND STEEL INSTITUTE, at 10.30 a.m.—Annual Meeting.

THURSDAY, MAY 13.

ROYAL SOCIETY, at 4.30.—*Probable* Papers: An Attempt to cause Helium or Argon to pass through Red-hot Palladium, Platinum, or Iron: Prof. Ramsay, F.R.S., and M. W. Travers.—On the Negative After-Images following Brief Retinal Excitation: Shelford Bidwell, F.R.S.—A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media: Dr. J. Larmor, F.R.S.—On a New Method of Determining the Vapour Pressures of Solutions: E. B. H. Wade.—On the Passage of Heat between Metal Surfaces and Liquids in Contact with them: T. E. Stanton.—On the Magnetisation Limit of Wrought Iron: H. Wilde, F.R.S.

ROYAL INSTITUTION, at 3.—Liquid Air as an Agent of Research: Prof. J. Dewar, F.R.S.

MATHEMATICAL SOCIETY, at 8.—On Cubic Curves as connected with certain Triangles in Perspective: S. Roberts, F.R.S.—An Analogue of Anharmonic Ratio: J. Brill.—An Essay on the Geometrical Calculus (Continuation): E. Lasker.—On the Partition of Numbers: G. B. Mathews.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Generation of Electrical Energy for Tramways: J. S. Raworth. (Discussion.)—Disturbances of Submarine Cable Working by Electric Tramways: A. P. Trotter.

FRIDAY, MAY 14.

ROYAL INSTITUTION, at 9.—Explosion-Flames: Prof. Harold Dixon, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MAY 15.

GEOLOGISTS' ASSOCIATION.—Excursion to Chislehurst. Directors: W. Whitaker, F.R.S., and T. V. Holmes. Leave Charing Cross (S.E.R.) at 1.35; arrive at Chislehurst 2.19.

LONDON GEOLOGICAL FIELD CLASS.—Excursion from Snodland to Aylesford, to view the Gault. Leave Cannon Street 2.37.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Treatise on Rocks, Rock-Weathering, and Soils: G. P. Merrill (Macmillan).—Birds of our Islands: F. A. Fulcher (Melrose).—A Plea for the Unborn: H. Smith (Watts).—Through a Pocket Lens: H. Scherren (R. T. S.).—Researches on the Evolution of the Stellar Systems: Dr. T. J. J. See, Vol. 1 (Lynn, Mass., Nichols).—A Course of Practical Histology: Prof. E. A. Schäfer, 2nd edition (Smith, Elder).—Dynamic Sociology: L. F. Ward, 2 Vols., 2nd edition (New York, Appleton).—A Handbook to the Birds of Great Britain: Dr. R. B. Sharpe, Vol. iv. (Allen). Papers and Notes on the Genesis and Matrix of the Diamond: Prof. H. C. Lewis (Longmans).—The North-Western Provinces of India: W. Crooke (Methuen).—Grundriss der Entwicklungsgeschichte des Menschen und der Säugethiere: Dr. O. Schultze, Zweite Hälfte (Leipzig, Engelmann).—First Stage Physiography: A. M. Davies (Clive).

PAMPHLETS.—Le Climat de la Belgique, 1896: A. Lancaster (Bruxelles). Réunion du Comité International Permanent pour l'Exécution de la Carte Photographique du Ciel, Mai 1896 (Paris, Gauthier-Villars).—A Study in Insect Parasitism: L. O. Howard (Washington).—Philosophical Transactions of the Royal Society of London: On the Capacity and Residual Charge of Dielectrics as affected by Temperature and Time: J. Hopkinson and E. Wilson (Dulau).—A Summary of Progress in Petrography in 1896: W. S. Bayley (Waterville, Me.).—Hermann von Helmholtz: Gedächtnissrede von Emil du Bois-Reymond (Leipzig, Veit).

SERIALS.—Chambers's Journal, May (Chambers).—History of Mankind: F. Ratzel, translated, Part 18 (Macmillan).—Journal of the Chemical Society, April (Gurney).—Century Magazine, May (Macmillan).—Bulletin of the American Museum of Natural History, Vol. 8 (New York).—Proceedings and Transactions of the Nova Scotian Institute of Science, Session 1895–6 (Halifax, N.S.).—Proceedings of the American Association, Buffalo, N.Y., August 1896 (Salem).—Report of the International Meteorological Congress held at Chicago, August 21–24, 1893, Part 3 (Washington).—Contemporary Review, May (Isbister).—National Review, May (Arnold).—Journal of the Essex Technical Laboratories, Vol. 2 (Chelmsford).—The Humanitarian, May (Hutchinson).—Quarterly Journal of Microscopical Science, April (Churchill).—Proceedings of the Royal Society of Victoria, Vol. ix., new series (Melbourne).—Himmel und Erde, April (Berlin),

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THURSDAY, MAY 13, 1897.

BOOKS ON BIRDS.

Life-Histories of North American Birds, from the Parrots to the Grackles, with special reference to their Breeding Habits and Eggs. By Charles Bendire, Captain and Brevet-Major, U.S.A. (retired). 4to, pp. ix + 518; with seven lithographic plates. Smithsonian Institution. United States National Museum. Special Bulletin. (Washington: Government Printing Office, 1895.)

Feathered Friends: Old and New. By Dr. W. T. Greene, M.A., &c. 8vo, pp. 302. (London: L. Upcott Gill, 1896.)

Coloured Figures of the Eggs of British Birds, with Descriptive Notices. By Henry Seebohm, author of "Siberia in Europe," &c. Edited (after the author's death) by R. Bowdler Sharpe, LL.D., &c., Assistant Keeper, Sub-Department of Vertebrata, British Museum. Pp. xxiv + 304. (Sheffield: Pawson and Brailsford, 1896.)

A Handbook to the Game-Birds. By W. R. Ogilvie-Grant, Zoological Department, British Museum. Vol. ii. Pheasants (continued), Megapodes, Curassows, Hoatzins, Bustard-Quails. (Allen's Naturalist's Library. Edited by R. Bowdler Sharpe, LL.D., F.L.S.) Pp. xvi + 316. (London: W. H. Allen and Co., Ltd., 1897.)

Among British Birds in their Nesting Haunts, illustrated by the Camera. By Oswin A. J. Lee. Parts 1 to 3. (Edinburgh: David Douglas.)

THIS volume of the life-histories of North-American birds, the third of the series of Special Bulletins issued by the Smithsonian Institution for the illustration of its collections deposited in the United States National Museum, is the second devoted to the land birds of the United States, and is from the same pen as its predecessor, the well-known Curator of Oology in that Museum, Captain Bendire. It is with very deep regret that we observe the recent announcement that death has snatched from his hands the completion of the task for which he was so competent by his untiring observations of many years, and in which he took the deepest interest.

The present volume treats of the parrots, cuckoos, trogons, kingfishers, woodpeckers, goat-suckers, swifts, humming-birds, cotingas, tyrant-flycatchers, larks, crows, starlings, and *Icteridæ*, the classification of the Code and Check-list of the American Ornithologists' Union being followed, as in Captain Bendire's first volume. He monographs 197 species, and especially discusses the range of the birds, their breeding habits, dates of nesting, and the description of their eggs. The latter are illustrated by natural-sized chromolithographs of 110 species on seven plates, nearly all of them executed with great fidelity to nature.

The life-history of each species is full and accurate, while many of the facts given are recorded for the first time as the result of Captain Bendire's own observations in many parts of America. He has laid under contribution those, also, of his numerous personal correspondents and of his brother ornithologists throughout the States. The outcome of the whole is a solid contribution to our knowledge of the families discussed. The plates, as already said, are excellent, and the text is beautifully printed on rich, smooth paper, in the sumptuous style of the Smithsonian Committee, who, having decided that a work is worthy to be published by them, spare no cost in worthily sending it forth to the world.

Dr. Greene's book, "Feathered Friends," contains, apparently, a reprint of articles contributed elsewhere. The "Friends" noticed are exclusively cage birds; and the information about them, which might have been condensed with advantage by the omission of many of the puerile stories of the Joey and Cat adventure type, contains, no doubt, some hints useful to those who keep birds in captivity, for whom, indeed, the volume is apparently intended. The woodcuts, which illustrate some of the species described, are not of the highest style of art or reproduction.

Henry Seebohm's "Coloured Figures of the Eggs of British Birds" is, to all intents, a new edition of the fourth volume, the plates, of his British birds, with the addition of the descriptions of their nests and eggs copied from that work, with a condensed account of the distribution of each species, its laying time and breeding places. The author's lamented death before its completion necessitated the bringing out of his book under the editorship of his friend Dr. Sharpe, who has done his best to present it as he believed Mr. Seebohm would have wished it to be issued. The book, as now published, is very complete, and for the oologist is quite independent of the large four-volume "British Birds." This handsome and somewhat bulky volume contains sixty plates with the figures of the eggs of 377 species of birds, and where the eggs are subject to variation, a series of the more characteristic deviations from the normal type has also been represented. We are safe from contradiction in saying that no work on British oology has been produced in this country in which the eggs have been so faithfully and artistically reproduced; as an example, we may refer to those of the kestrels and the guillemots on Plates 4 and 55 respectively. The book will, undoubtedly, remain the standard authority on the eggs of British birds for many years to come.

Dr. Sharpe has prefaced the work with an interesting and appreciative "personal reminiscence" of the author, in which Seebohm's chief contributions—and they are numerous and important—to ornithology, are summarised, and some of his many generous gifts to the National Collection, of which he was a constant benefactor, are rather indicated than fully detailed. A specially successful photogravure likeness of Mr. Seebohm forms a fitting frontispiece to the volume. It ought to be mentioned that the chromolithographic plates are the work of Messrs. Pawson and Brailsford, of Sheffield, and they prove that the highest class of chromolithography can be done as well in England as anywhere on the continent.

The second volume of Mr. Ogilvie-Grant's "Game-Birds" forms the latest addition to Allen's Naturalist's Library. His previous volume showed him to be a most accurate and conscientious worker, and that now under review will sustain his reputation in these respects. The British Museum is fortunate in possessing one of the most complete collections of game-birds in the world, only eighteen species of those known to science being

unrepresented in it. Mr. Grant has, consequently, in preparing his two volumes, had the opportunity, of which he has with infinite pains availed himself, of comparing his descriptions with the specimens in the National Collection. It is not too much to affirm that, as a guide to this group of birds, these two volumes have no superior, and though condensed, all the essential facts of their life-histories, so far as known, are carefully set out. As the editor justly remarks, they constitute "a small monograph of the *Gallinæ*." Two species are described in this volume as new, namely *Turnix whiteheadi*, one of that excellent naturalist's numerous discoveries in the Philippines, and *Ammoperdix cholmleyi* from the Soudan.

We have had more than once to note the unsatisfactory character of the plates in Allen's Naturalist's Library. There is, however, a slight improvement in this respect in the eighteen illustrations in the present volume, as compared with those of several of its predecessors; but as bird portraits they are still far from what they ought to be, especially in a work where the standard of the text is so high. Considerable carelessness is seen in Plate xxxiv., for instance, where the colouration differs widely from the description, the result of the cheap way in which the chromolithography has been executed. The poorness of the plates, however, cannot seriously interfere with the value and usefulness of this excellent handbook.

Mr. Oswin Lee presents us with still another work on British birds! Believing that among the number of books which have been published on British birds and their eggs, many of which are beautifully illustrated, there has never been published, so far as he is aware, any complete work giving faithful representations of their nests, he essays to supply the need by issuing to subscribers, at intervals of four to six weeks, a fascicle of photographs, which he hopes "will possess the accuracy of a scientific work on the nesting habits of birds, and yet be sufficiently attractive for the ordinary lover of birds." As to the excellence of the photographs as pictures, and of the general "get-up" of the work, as judged by the portions so far issued, we can speak with unqualified praise; that the latter, indeed, should be all that can be desired, goes without saying when we mention that the publisher is Mr. David Douglas, of Edinburgh. The plates are the *raison d'être* of the book, but each illustration is accompanied by "short descriptions of the habits of the birds at the nests, the finding of them, the materials of which they are formed, and the methods employed in getting faithful photographs of those more difficult of access, some of which . . . were only secured after hours of anxious watching and much patience." The difficulties to be overcome, and the patience required to secure a satisfactory plate of a bird on or by its nest, in a natural attitude, are, we admit, very great; but we think that in many cases the results are far from commensurate with the time, trouble, and expense devoted to securing them. We have more than once expressed in these pages the opinion that, with regard to the majority of nests, a photograph, taken close enough to give the details of the materials of which they are composed, and the form and markings of the eggs, must fail to convey a true idea of their site, size, or surroundings. Take, for instance, the nests of the *Vanellus vulgaris*. No one looking at Plate i. would, without explanation, recognise it as a lapwing's nest, for it appears as if composed of large twigs placed amid strong brushwood, the photograph having been taken at close quarters, and there being no object in the picture to suggest the dimensions of the eggs and grass relatively to the area occupied. Again, that on Plate ii., instead of giving one the impression of being on a ploughed field, as is intended, seems to be built in a nook in the face of a precipitous cliff! On the other hand, the illustration of the cormorant's nest is most charming. Here we have the nest and its eggs in the foreground of a little bit of scenery which forms a true scale for our mental picture. Photographs fail, we think, too, in suggesting the texture, character, and markings of the eggs. These are faults inherent to all camera pictures. Mr. Oswin Lee's photographs are, however, the best we have seen; and his notes, if short and containing, as a rule, few new observations, are generally his own, and are interesting and accurate. The small etched tail-pieces, from his own pencil, are delightful, and often catch with great fidelity some characteristic attitude of the birds he has been describing.

GEGENBAUR'S FESTSCHRIFT.

Festschrift zum Siebenzigsten Geburtstage. Von Carl Gegenbaur. Vols. i., ii. and iii. Pp. 436, 486, and 788. (Leipzig: Engelmann, 1896.)

THE three large volumes of essays and researches by the friends and pupils of Gegenbaur, form a very remarkable monument to the influence which the great Heidelberg Professor has exercised in the world of science.

The list of distinguished zoologists who contribute to the "Festschrift" would alone attract attention, and render the book worthy of a place in every zoological library; but the impression given on reading it, is that every one of the contributors has given his best work to the volume which does honour to the great master.

To fairly criticise the several essays, or even to notice the principal discoveries and conclusions made by the different authors, would almost mean a review of modern zoological research, for the contributions deal with a great variety of zoological problems and classes of animals.

It is true that the majority of Gegenbaur's pupils have written on subjects of vertebrate anatomy; but the essays on invertebrate morphology are none the less interesting and important.

The first, and in many ways the most striking, memoir is the one by Haeckel, on the Amphoridea and Cystoidea. All through the descriptions of genera and species, which form the greater part of the essay, the reader must feel the genius of Haeckel's extraordinarily powerful and fertile mind.

Many cautious palæontologists may complain that there is too much imagination about the work; that there is little proof that the restorations represent, even approximately, the form that these extinct animals possessed. But there is not really much difficulty in distinguishing between what is recorded fact and what is not, and the real gain to science in such a memoir is that we have a clear and concise picture given to us, in words and illustrations, of the thoughts about a group

of fossils by one who has thoroughly studied them, and can boldly write down his views.

The memoir will, doubtless, be severely criticised; but it is a notable piece of work, and one which all zoologists may read with advantage.

The first part of Richard Hertwig's memoir, on the development of the unfertilised egg of the sea-urchin, deals almost entirely with the phenomena of nuclear structure and division, and the influence upon them of strychnine and other reagents. The second part of "General Considerations" is an elaborate and exceedingly clever essay on nuclear structure and sexual differentiation.

One of the most important conclusions arrived at, is that the centrosome is a body derived from the nucleus, which passes into the protoplasm of the cell in order to bring into more intimate connection the nucleoplasm and cytoplasm during the process of cell-division.

He points out that, in such cases as Actinosphærium and other Protozoa, and in the formation of the polar bodies of Asteracanthion, where centrosomes are not apparent, there is very slight connection between nuclear division and division of the surrounding protoplasm.

The argument is not convincing, and, as Farmer has recently shown, must be considerably strengthened from the botanical side, at least, before the theory can be accepted.

G. von Koch's essay, on the skeleton of the stony corals, is important and interesting; but it will not attract so much attention as it might have done, had not Miss Ogilvie's memoir, recently published by the Royal Society, been more elaborate and, many will think, better.

Of the memoirs dealing with the anatomy and development of Vertebrata, the one by Hubrecht, on the development of Tarsius, is the most noteworthy. Although the essay is compressed into only thirty pages, and illustrated by but one plate and fifteen figures in the text, it may be regarded as a summary of the most important results of this distinguished embryologist's work.

It is quite certain that the peculiar features of the early development and placentation of the Spectral Lemur could have been rightly interpreted only by one who had worked previously at such mammals as the Insectivora. The extremely important resemblance which the Tarsius embryo at a certain stage presents to the human embryo, at what is probably a corresponding stage, is pointed out by Prof. Hubrecht, and the general features are illustrated by a plate of interesting and instructive diagrammatic figures.

But the memoir is not only strictly embryological; it deals with the zoological position of Tarsius from other points of view, and the conclusions are arrived at, firstly, that Tarsius is, as regards its dentition, intermediate between the Primates and the Mesozoic Insectivora, and secondly, that Cope's genus Anaptomorphus is intermediate between Tarsius and Man.

Of the other memoirs on Vertebrata, two seem to stand out prominently as of more than usual interest and importance. These are the essay, by Klaatsch, on the application of Gegenbaur's famous Archipterygium theory to the question of the origin of the pentadactyle limb, and Rosenberg's memoir on the vertebral column of *Myrmecophaga jubata*.

The former places before the student a clearly-expressed and carefully-considered theory, and is illustrated by numerous really admirable figures. Rosenberg describes some variations he has met with in the vertebral column of Myrmecophaga, and discusses fully the vexed question of the homologies of the Vertebræ in the Mammalia.

Other contributions to this work have been made by Boas, Oscar Hertwig, Corning, von Davidoff, Solger, van Bemmelen, Scott, Seydel, Maurer and Göppert; and it is not faint praise to say that they are well worthy of a place in these volumes.

Since the above was written, the third volume of this gigantic "Festschrift" has been forwarded to us. It is even larger and more profusely illustrated than the first two volumes, and is entirely devoted to questions of vertebrate anatomy. Four of the seven memoirs are concerned with the cranial and spinal nerves. Goronowitsch confines his attention to the Trigemino-facialis complex of Lota, and Haller to the Vagus group of the bony fish, the two essays taking the modest share of one hundred pages.

Unfortunately, perhaps, G. Ruge, who writes on the facial nerve of vertebrates, and Fürbringer on the spino-occipital nerves of the cartilaginous fish, have been unable to confine their contributions within these limits. To attempt to criticise the 600 pages which they take, would mean an attempt to criticise an encyclopædia of vertebrate knowledge. The student, however, will find in them a mass of solid facts which have important bearings on many important questions that are much discussed in these days. Fürbringer's memoir in particular, although overpowering in its size, has many passages which summarise, in a clear and masterly manner, questions of the homologies of nerves, and in this respect, at any rate, will form a most useful work of reference for anatomists.

Of the remaining three monographs the most important appears to be the one by Semon, on the excretory system of the Myxinoids. As in the earlier works of this distinguished anatomist, the reconstruction figures he gives are admirable.

Max Weber's interesting essay on the brain weight of Mammals, and Leche's researches on the teeth of recent and fossil Lemurs, are important contributions to knowledge; and although much shorter than others in this volume, are not the less valuable indices of the character of the work that has been produced by the pupils of Carl Gegenbaur.

THE DREARY DESERT OF NORTH TIBET.

Works of the Tibet Expedition of the Years 1889–1890, *under M. V. Pyevtsoff*; Part iii. 4to, pp. 127; with six maps. Published by the Russian Geographical Society. (Russian.) (St. Petersburg, 1896.)

THIS third part of the excellent publication issued by the Russian Geographical Society, contains the records of the incursions of Roborovsky and Kozloff into the border-ridges of the great Tibet plateau. While the main body of the expedition followed the northern foot of the Astyn-tagh border-ridge (or the "Russian Moun-

tains"), *viâ* the oases Niya and Cherchen, to lake Lob-nor, Roborovsky and Kozloff, with two or three men, pushed into the mountains, and beyond, into the wildernesses of the northern part of the Tibet plateau. These excursions, which were made under great difficulties, and in one of which Roborovsky's party was very nearly lost, are described in the present part of the "Works" of the expedition, and illustrated by six maps on the scale of 13 miles to an inch. The most important of these reconnoitring expeditions was the second, made by Roborovsky, when he crossed the Astyn-tagh, and, following a valley at its south-eastern foot, between the Astyn-tagh and the steep snow-covered Uzu-tagh, reached the Keria river, as it issues from the Tibet plateau and turns north-westwards, fringing the mighty glacier-covered Kuen-lun. No inhabitant of Kashgaria ever went that way, and nobody ever came to Kashgaria from that quarter; only a few gold-diggers visit the above-mentioned valley, without ever daring to penetrate further south into the dreary wilderness of the high plateau. Roborovosky did so, notwithstanding the terrible snow-storms, one of which, on May 22, covered the ground with three inches of snow. After having reached the Keria river, which flows at an altitude of 14,300 feet, and must be a mighty stream in summer, Roborovsky returned; but he came once more to the same spot, a couple of weeks later, moved by the desire of crossing the Uzu-tagh and of casting a glimpse on the dreary desert in the south of it. The altitude of the desert was 16,600 feet, and on June 12–14 almost no signs of life were found on it. Its surface is covered with low rows of stony hillocks, consisting of sharp-edged broken strata of quartzite, running west and east. A few bushes of a willow were found after a 22 miles' march, but no lichens were seen; and the only animals noticed were a few broken-down *orongo*-antelopes, which slowly walked within a few yards from the party—too weary to pay attention to it. Only snow seems to fall all the year round in this desert, and rain must be quite unknown. In June, snow fell every day, and evaporated immediately. On June 15 the altitude was 17,080 feet, and the temperature $-12°$ Celsius in the morning. The horses were severely suffering from the sharp stones, and broke down; so that the party was compelled to return, after having covered only 40 miles southwards. The desert stretched further south, as far as the foot of the snow-covered Kuen-lun. The return journey was extremely difficult, one horse only being able to stand it; and it was in a desperate condition that Roborovsky's party reached a spot where they had left some of their provisions.

The sand-storms in that part of Kashgaria, at the foot of the mountains, are simply terrible. The loess-terrace, which fringes the highlands, is easily destroyed by the wind, and the dust is carried in the air, becoming occasionally so dense that complete darkness prevails —nothing being seen at a distance of some ten yards. If it rains during such a dust-storm, the drops of rain evaporate as they fall, and the dust they carry with them falls in the shape of small lumps. Whole forests of poplars are buried in the loess-dust hillocks, forty feet high being blown round the trees, which soon die and slowly decay, after the wind has carried the hillock away, to spread the dust further on.

Another excursion into the highlands, during which nearly 500 miles were covered and mapped, was made to lakes Achik-kul, Chom-kum-kul, and "Unfreezing"—a salt lake at an altitude of 13,300 feet, which has various species of *Gammarus* among its fauna—and to Prjevalsky's Ridge, which is a mighty chain of mountains, buried in snow, running west and east under a number of local names, and very rich in animal life in its northern spurs.

A fourth excursion was made along the Cherchen-daria, which flows in a flat-bottomed valley, and has on both its sides two strips of sands, arranged by the wind in the shape of *barkhans* (rows of hillocks), attaining the extraordinary height of 360 feet. Great numbers of wild camels, stags, antelopes, wild cats, boars, and masses of small rodents and spiders, belonging to a variety of species, inhabit these sands, while the banks of the river are covered with poplars, tamarisks, and rushes. Traces of recent desiccation are found everywhere, and immense spaces are occupied with marshes, now covered with rushes, and strewn up with masses of fresh-water molluscs —the former inhabitants of a great lake. The population of the Lob-nor depression consists of half-breeds between Aryans and Turco-Mongols, who live in huts made of rushes, keeping some cattle, and carrying on fishing to a great extent.

The accounts of Roborovsky's and Kozloff's excursions to lake Bagrach-kul, near Karashar, and Kozloff's, up the Konche-daria, are also full of interest, and, like the preceding, give a good idea of the physical characters, flora and fauna, of the visited regions. General Pyevtsoff's discussion of Roborovsky's altitudes and astronomical observations completes this very interesting volume.

P. K.

OUR BOOK SHELF.

Algebra for Beginners. By T. Todhunter. New edition, revised and enlarged by S. L. Loney. Pp. xxxvi + 428. (London: Macmillan and Co., Ltd., 1897.)

THIS excellent elementary treatise is too well known to require detailed description in these columns, so we need only refer to the changes which have been made by the reviser of the new and enlarged edition. Prof. Loney has given additional chapters on negative quantities, the theory of quadratic equations, logarithms, and miscellaneous theorems, each of which has been inserted in those parts of the book which seemed most appropriate. The chapter on factors has been rewritten, and chapters towards the end have been considerably expanded. By renumbering the paragraphs, and maintaining the old numbers in smaller type, the reviser has facilitated the use of employing both editions together; the newly-added paragraphs contain only one—namely, the new—system of numbers. As examples form a very important part of such an elementary book as this, Prof. Loney has thought fit to more than double the original number, the answers being, as usual, included in the list at the end. Teachers will thus find in this edition a most complete and efficient course, and one especially adapted for boys commencing the subject.

Picture Lessons in Natural History. A series of diagrams on roller. (London: G. W. Bacon and Co., 1897.)

THE four sheets before us, which, we presume, form only a portion of the series, include the Protozoa and "Invertebrates." From all points of view they seem admirably

adapted to give to the young student a clear idea of the leading structural features distinctive of the different groups of animals. The figures are well selected, well drawn, and well coloured, and are of a size sufficiently large to display the structure of each type of animal. The letter-press is written in exact and yet such popular language as to be easily understood by the most unscientific.

Although the author has seen fit to conceal his identity, certain peculiarities in spelling (*e.g.* "armored" and "centipeds") suggest that he is an American. It would have been better if a little more attention had been given to proof-reading, and we should not then have met with "chitin" on one sheet, and "chitine" on the next, while certain errors in punctuation would have been avoided. It seems a pity to allude to the argonaut as the nautilus, and a figure of the pearly nautilus ought certainly to have been introduced. We fancy, too, that the common gaper (*Mya*) will be somewhat unfamiliar to English students under its American title of "clam." R. L.

A Guide to the Fossil Invertebrates and Plants in the Department of Geology and Palæontology in the British Museum (Natural History). Pp. xvi + 158. (Printed by order of the Trustees, 1897.)

THE guide-books prepared by officials of the Natural History Museum at South Kensington, to interest visitors in the collections under their charge, are models of what guide-books should be; they are concise in text, often well illustrated, and marvellously cheap; and the persons who digest them obtain a liberal education on the subjects with which they deal. In this new Guide, prepared under the direction of Dr. Henry Woodward, the fossil invertebrates and plants represented by specimens and drawings in the Natural History Museum are described; the characteristics of the living organism, as well as of the parts found in a fossil state, being placed before the reader. With this Guide in his hand, the student of geology and palæontology will be able to derive the fullest advantage from the admirably-arranged geological record at South Kensington.

Report on the Causes and Prevention of Smoke from Manufacturing Chimneys. By Dr. Harvey Littlejohn, M.A., M.B., B.Sc., Medical Officer of Health. Pp. 51. (Sheffield: Wm. Townsend and Son, 1897.)

DR. LITTLEJOHN drew up this report, upon the subject of the smoke nuisance in Sheffield, at the request of the Health Committee. He gives a short account of the past history of the subject, which occupied the attention of a Select Committee of the House of Commons so far back as 1819. Sheffield has an unenviable notoriety for smoke, owing, of course, to the fact that a large number of its manufactures depend almost wholly upon the combustion of coal. Dr. Littlejohn suggests that further restrictions be imposed on the amount of smoke emitted by steam-boiler furnaces, but no special form of apparatus for preventing excessive smoke is recommended, the opinion being that greater care and attention in firing would considerably lessen the nuisance.

Birds of Our Islands. By F. A. Fulcher. Pp. 368. (London: Andrew Melrose.)

WITH the multitude of readable books which now exist on British birds, it is almost a reproach to be without a knowledge of bird-life. In this dainty volume the characteristics and habits of birds, and the curiosities of bird-land, are pleasingly described. The book is not an exhaustive treatise, but a collection of word-pictures drawn by the author in various parts of the British Isles. It is simple-worded; nevertheless, it is instructive, and it will lead its readers to look about them so as to see for themselves how interesting are the works of nature. The book would be a very acceptable present for a boy with a taste for natural history.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Theory of Dissociation into Ions.

I AM glad that Mr. Dampier Whetham has noticed the two experiments which I adduced against the present theories of osmotic action and dissociation respectively. The force of the first of these experiments he admits, but, as regards the second, I fear that he can hardly have realised the true results of the experiment, or else I do not realise the meaning of the explanation which he offers of it.

The experiment was: That when a mixture, represented by $100H_2O + H_2SO_4$, is put into excess of acetic acid, the lowering of the freezing-point of the latter shows that the mixture contains less than 101 acting units, instead of more, as would be the case if the H_2SO_4 molecule was dissociated into ions. The actual number of acting units indicated was about 70. (I have only an abstract of the paper by me: it will be found in the *Berichte*, 24, p. 1579.) Mr. Whetham's explanation is that the acetic acid takes the water away from the sulphuric acid, and this latter goes into solution as such in the acetic acid, and in this solvent it is undissociated. But even if this were so—and a determination of the conductivity of the complex solution should tell us at once whether it is, or not—we should still have our 101 acting units ($100H_2O$ and H_2SO_4) in the acetic acid, or, even if the sulphuric acid molecules combined with each other to form complexes, we should have, at any rate, something more than 100 units; whereas, as a matter of fact, we find only 70. Complete recombination of ions, and complete polymerisation of the sulphuric acid is quite incapable of explaining the reduction of the number of acting units present.

To quote some actual values: 16·8 molecules of water lower the freezing-point of 100 molecules of acetic acid 7·32°; 0·097 of a molecule of sulphuric acid lowers the freezing-point of 100 molecules of acetic acid 0·038°; the two together should lower the freezing-point of acetic acid 7·358° if they acted on it independently of each other, but the actual lowering which they produce is only 7·03°; therefore, they do *not* act independently of each other. The two together have even less action than the water only.

As an alternative explanation, Mr. Whetham suggests that "dissociation of the ions from *each other* does not forbid the assumption that the ions are linked with one or more solvent molecules." Quite true: but when a theory can only explain observed facts by driving us to assumption of the existence of such compounds as H_xH_2O and $SO_4\,yH_2O$, I venture to think that that theory must be somewhat shaky.

Harpenden, May 1. SPENCER PICKERING.

I AM very glad that Mr. Pickering has given further details of his experiment. From his former letter I did not gather that the number of acting units indicated by the freezing-point of the solution of $100H_2O + H_2SO_4$ in acetic acid was as low as now appears. The result is most interesting, and seems to me to furnish strong evidence for the modification of the dissociation theory for which I am contending, under the belief that, in spite of the last paragraph of Mr. Pickering's present letter, it furnishes the best explanation of *all* the facts. Had the number of acting units indicated been nearer 100—say 90, or more—it would have been possible to explain the experiment in the first way which I suggested, for the freezing-point of a solution of water in acetic acid shows that some of the solute molecules are polymers of H_2O (Raoult's value for the molecular depression is 33·0, as compared with 38·8 found from Van 't Hoff's formula, which agrees well with Raoult's values for other substances). This would reduce the number of acting units in the case of the mixed solution also, and even complete dissociation of the sulphuric acid would be insufficient to bring that number up again to 100.

This explanation, however, seems to me to be entirely upset by the result that the lowering of freezing-point produced by a mixture of water and sulphuric acid is actually less than that produced by the water alone. Certainly, as Mr. Pickering says, the water and sulphuric acid "do not act independently of each other"—at least, when dissolved in acetic acid. I do not think it quite logically follows that they are combined when

alone; but it certainly seems probable, and I have no wish to raise such an objection.

If we admit, then, that combination does occur when sulphuric acid is dissolved in water, as there is much evidence to show, need we abandon the dissociation theory? I think not; in fact, Mr. Pickering admits that my alternative explanation meets the case under discussion.

Mr. Pickering has made no attempt to explain the electrical phenomena I described in your issue of April 29, by any means other than the assumption of dissociation of the ions from each other. I know the idea of such dissociation is abhorrent to people who are fortunate enough to possess an orthodox chemical conscience; but, till some one has accounted for the electrical relations in another way, its acceptance seems to me to be a necessary consequence of the facts.

I cannot quite see the force of Mr. Pickering's objection to the idea that the ions are linked with one or more solvent molecules. There is no need to assume the existence of definite compounds, which could be crystallised out and handled. If we admit the presence of charged ions free from each other, electrical forces will certainly exist between them and the solvent. We know too little, as yet, about the mutual relations of atoms and their charges, to picture exactly what occurs; but these forces must produce some sort of connection between the ions and the molecules of solvent. This connection, of course, only remains unmodified as long as the dissolved body keeps in solution.

Such a view of the dissociation theory seems to me to offer many advantages. It may be contrary to some *opinions*, but I do not think any *facts* have yet been pointed out which refute it. Till they are, it may possibly be of some use as a working hypothesis in the investigation of that complicated structure which we call a solution. W. C. DAMPIER WHETHAM.

Trinity College, Cambridge, May 5.

On the Feathers of "Hesperornis."

A NUMBER of years ago I published in NATURE (December 25, 1890, p. 176) my opinion "On the Affinities of *Hesperornis*," agreeing, at the time, with Prof. D'Arcy Thompson and others, that those toothed birds of the Kansas Cretaceous beds saw their nearest allies in existing birds in the Loons and Grebes, or in the typical Colymbidine assemblage. In other words, the now-living pygopodous birds, such as *Urinator*, *Colymbus*, and so forth, are, by descent, the modern representatives of the ancient *Hesperornithidæ*, whether that descent or origin be direct or indirect. There are osteological characters, which the limitations of space will forbid dwelling upon here, that tend to convince me of the probability of the Grebes (*Podicipoidea*) being an earlier offshoot of the pygopodine stem than the *Urinatoroidea*, and so more nearly related to *Hesperornis* than the latter birds.

Re-stimulated by a brief article, by Prof. S. W. Williston, in *The Kansas University Quarterly* (vol. v., July 1896, pp. 53, 54, plate ii.), entitled "One of the Dermal Coverings of *Hesperornis*," Prof. O. C. Marsh takes occasion, in a recent issue of NATURE (No. 1432, vol. lv., April 8, 1897, p. 534), to once more advance the theory—and one which originated with him, and, fortunately, has received but meagre support—of *Hesperornis* having been nothing more nor less than some peculiar kind of "a swimming ostrich." This view of its taxonomic position has never been accepted by the present writer; and it would seem that many other comparative anatomists experience quite as much difficulty in believing that those ancient divers were any more "swimming ostriches" than the modern types of the *Struthionidæ* are a sort of group of gigantic terrestrio-cursorial divers.

Prof. Marsh is not the only writer that has been led astray in some parts of avian classification by employing what have been called "struthious characters" in avian osteology, and now he thinks his views are supported by the recent discovery of Williston, referred to above. Having carefully examined the published plate of the latter author, I must say that I am quite sceptical as to what he believes to be long tarsal feathers in *Hesperornis*. Surely, in the figure, the resemblance to feathers is very remote; and, quite as surely, long, drooping plumaceous feathers hanging down *to the feet* in a big, powerful *diver*, would in no way whatever assist it in either swimming or diving. In fact, just so soon as these soft, plumaceous feathers became thoroughly wet, they would naturally form a serious impediment to the proper use of the pelvic limbs in their forward and backward strokes; and one has but to study the action of these limbs in swimming, in our modern Loons, to appreciate this point. That *Hesperornis* possessed some kind of a plumaceous plumage, however, I long ago believed, and see no reason to change that opinion now.[1]

Plumaceous plumage was very likely far more prevalent among the earliest birds in time, than it is now among the modern types; and this applies absolutely to not a few characters in the skeleton. The latter, along whatever line we may trace them, are evidences of an approach reptile-wards, and by no means always point to struthionine affinity. Certain peculiarities in the pelvis, and at the base of the cranium, when associated with certain others, have, as I say, been unfortunately termed "struthious characters," and, with this mistaken idea operative, our more superficial avian anatomists can see but little beyond "ostrich" in either *Finamon* or *Apteryx*. Not so, however, is this the case with the more profound researchers, of which Prof. Max Fürbringer is so able a representative. There is no more ostrich in *Hesperornis* than there is diver in *Struthio*—how much of the latter there may be, I willingly leave Prof. Marsh to consider. R. W. SHUFELDT.

April 28.

On Augury from Combat of Shell-fish.

IN his "Jôzankidan Shûi" (published about 1767, tome i. fol. 3, *a*) Yuasa Shimbei, a Japanese literatus (1708–81), writes on this subject thus:—"Noma Samanoshin narrated that the destiny of a belligerent could well be foretold by means of the 'Tanishi.'[2] If two groups consisting each of three of this shell-fish be placed in opposite corners of a tray, the three animals representing the future conquerors would advance, while the others, which are doomed to defeat, would withdraw. This method was approved by repeated experiments during the siege of Osaka [1615].[3] Every time the experiment was carried on, it never failed for the three 'Tanishi,' respectively designated Hideyori, the lord of the castle, and his two generals, Ôno and Kimura, to be driven in corners by other three which were representing the leaders of the besieging army, Prince Iyeyasu, Ii, and Todô. Thence it is confirmed that there is no better method of foretelling the decision of a war [here Noma's narrative ends]. The same method is given in detail in 'Wu-pei-chi' [by Mau Yuen-i, completed 1621], which is to be consulted for its particulars." Unfortunately all four copies in the British Museum of the Chinese work, here referred to, are wanting vol. clxxxvi., wherein further details of the method are said to be found.

Besides, two older Chinese works, both of which I have never seen, viz. Fung Ching's "Pan-yu-ki"[4] (written *circa* 990–94) and Luh Wei's "Kwei-che-chi"[5] (twelfth century) are said to describe this method of augury to have been of old used in the region of Ling-Nan (which comprised the present provinces of Kwang-Tung and Kwang-Si).

In connection with Yuasa's statement above quoted, the following notice, by Etienne Aymonier, of a Cambodian mode of divination is equally interesting:—"Si une armée étrangère fait invasion dans le royaume, beaucoup d'habitants prennent deux *Khchau*,[6] placent au fond d'un bassin, d'un récipient, un peu de sable pour faire une petite arêne et assez d'eau pour recouvrir les deux coquilles. Ils allument des bougies et des baguettes odoriférantes, invoquent les divinités protectrices du royaume, les prient d'indiquer l'issue de la guerre au moyen de cette petite naumachie. Les *Khchau* représentant les belligérants luttent jusqu'à ce que l'un des deux soit culbuté"[7] ("Notes sur les Cou-

[1] See my article, "Feathered Forms of Other Days," *The Century Magazine*, January 1386, p. 357.

[2] "*Tannigi* are the common black Land Snails gather'd for Food in muddy Rice Fields. . . ." (Kaempfer, "History of Japan," 1727, vol. i. p. 141). It belongs to the genus Viviparus, and is *V. japonica*, if I remember correctly.

[3] For this event see, *e.g.*, Caron's "Account of Japan," in Pinkerton, "Voyages and Travels," 1811, vol. vii. p. 616; "Diary of Richard Cocks," 1883, *passim*.

[4] Referred to in Li-Ye, "King-chai-ku-kin-tau" (written *c.* 1234, Brit. Mus. copy, 15,316, *d*, tome iv. fol. 27, *a*).

[5] Quoted in the Grand Imperial Cyclopædia, "Ku-kin-tu-shu-tseih-ching," sec. xix. tome clxiii. sub. "Lo-pu-ki-shi," fol. 3, *a*.

[6] J. Moura, in his "Vocabulaire Français-Cambodgien, &c.," Paris, 1878, simply explains the word "khchau" as "coquille." From parallel instances it is highly probable that this is, too, a species of the Paludinidæ.

[7] This notice reminds me of an old Japanese tradition, which is this. "When the battle of Dannoura was about to be fought (1185) [for which battle see Adams, "History of Japan," 1874, vol. i. p. 36], Kumano-no-Bettô Tansô, a warlike priest, who was wavering in question which of the

tumes et Croyances superstitieuses des Cambodgiens," in *Cochinchine Française: Excursions et Reconnaissances*, No. 16, p. 142, Saigon, 1883).

So far the practice of augury from combat of shell-fish appears to be a peculiarity of the peoples in the Far East. Is there any instance of the same method described in other parts of the world?[1] KUMAGUSU MINAKATA.

May 3.

Luminous Phenomena Observed on Mountains.

On Easter Monday, 19th ult., I was ascending Braeriach by its well-known northern ridge, and, shortly after I had crossed the "snow-line," I witnessed a phenomenon of great beauty, the explanation of which I cannot give. The edge of my plaid, of my gloved hands, of my knickerbockers, &c., was bordered by a two-inch band of brilliant violet light, at the moment of beginning any movement. The light was not visible around anything at rest, nor did it persist; but only showed at the moment when rest was changed for movement.

My attention was directed to this for a very short time only, for heavy snow began to drive in my face, and I had to watch where I was going, as the immediate surroundings included dangerous ground.

After my return, I found an account of a somewhat similar appearance in the *Cairngorm Club Journal*, vol. i. p. 159. I copy the account as there given by Dr. John Gordon, of Aberdeen:—

"Half-way across the snow-slope, while the sun was somewhat obscured, but was still sending a considerable intensity of light, we observed a strange phenomenon. On the side of our body next the snow-slope there was a nimbus of violet light, which clung to clothes, naked fingers, and the shaft of the ice-axe. So plentiful did it appear in the palm of the hand that it looked at times like a pool of violet ink, and one thought it could be pitched away. On shaking the hand, however, the nimbus clung, and was not to be removed. Occasionally the colour varied, taking on shades of brownish-yellow and blue, but violet was the most marked colour. At another time, in much the same condition of light and snow surroundings, one of the party, who was very proud of the beauty of the silver case of his compass, was disgusted to find that it had a distinctly yellow, pinchbeck look. This light refraction or polarisation [?] was not so evident to some of the party, but the writer has observed it before in similar circumstances and atmospheric conditions."

I may add that, in my own case, no direct sunlight reached me, as I was in the lower part of a dense cloud or mist. Some of your readers may offer an explanation of this remarkable and beautiful appearance. C. G. CASH.

Edinburgh Academy, May 3.

The Utility of Specific Characters.

UNDER the above heading, in your issue of April 1, Mr. J. T. Gulick has an interesting communication, in which he asks whether it is possible to explain right-handedness, the dextral or sinistral coil of snail-shells, and similar features, as having any utility to the species of which they are certainly characteristic. Can it be due to natural selection that one snail is dextral, while another is sinistral?

It is a curious fact, I think first pointed out by Mr. Call, that in the American freshwater shells of the genus *Campeloma*, *sinistral shells are more numerous among the young than among the adults*. Thus, for example, Mr. H. A. Pilsbry (*Nautilus*, February 1897, p. 118), states that Miss Jennie E. Letson examined a lot of *Campeloma decisum* for him, with the result that, "out of 681 specimens, mainly adult, but including those from one-fourth grown up, none were sinistral. Out of 410 shells of the uterine young, 3 were sinistral, slightly over 0·73 per cent." He adds: "Probably all who have collected Campelomas have noticed the greater proportion of sinistral examples among the young shells. This doubtless indicates that the reversed condition is an unfavourable one for maturation."

So here, at any rate, we have some direct evidence as to selection. I think it will strike any one, that while left-handedness might be as good for the race as right-handedness, *there is a distinct advantage in uniformity*, and that consideration alone may perhaps suffice to explain Mr. Gulick's difficulty. Among plants it may seem less obvious, but where seedlings are crowded, uniformity may save space, just as a number of objects of the same shape can usually be packed into less space than those of diverse shapes. More plants can grow in a window-box where all bend to the light, than would be possible if half of them bent one way and half another.

There also occurs to me a theoretical consideration, perhaps of doubtful value. When a germ has diverse potentialities, so that it is left to germinal or environmental selection to decide which course it shall take in development, there must, apparently, be a certain waste of germinal energy. Any disadvantage thus arising is ordinarily much more than counterbalanced by the gain due to the adaptability of the organism, or in social species to the power of specialisation of the individual for social purposes. But it may be that when no such advantage is found, there exists a small disadvantage in deviations, potential or actual, from a common standard.

What we really need, in discussing these matters, is the observation of actual facts. The facts above related as to *Campeloma* are worth more than any amount of theoretical considerations. T. D. A. COCKERELL.

Mesilla, New Mexico, U.S.A., April 21.

The Motion of an Iron or Steel Ball in a Magnetic Field.

IN NATURE, April 29, a method, reprinted from the *Physical Review*, is given for illustrating the motion of a particle under the action of a force varying inversely as the square of the distance. I think it ought to be pointed out that the force on a small iron or steel ball, due to a single magnetic pole, is not inversely as the square of the distance. It may be shown without difficulty that if the strength of the pole be μ, the susceptibility of the iron or steel to magnetisation κ, and v the volume of the ball supposed exceedingly small, then the force towards the pole is

$$-\tfrac{1}{2}\cdot v\cdot\frac{\kappa}{1+\frac{4}{3}\pi\kappa}\cdot\frac{d}{dr}\left(\frac{\mu^2}{r^4}\right)$$

$$=\frac{2\kappa v}{1+\frac{4}{3}\pi\kappa}\cdot\frac{\mu^2}{r^5}.$$

Thus, assuming that κ is constant during the motion of the ball, which, of course, it is not, the force is inversely as the fifth power of the distance, and the curves given can not be regarded as even approximate representations of planetary orbits, but rather as rough representations of orbits described about a centre of force whose law is the inverse fifth (see "Tait and Steele," p. 151). ALEX. ANDERSON.

Queen's College, Galway, May 3.

THE NEW SOUTH AFRICAN MUSEUM.

THE new South African Museum is situated at the upper end of the Municipal Gardens, about a quarter of a mile distant from the old building, which will now be entirely occupied by the public library.

The new building consists of two floors, of which the upper one contains the principal exhibition rooms; the large room, measuring 63 feet by 41½ feet, is devoted to the birds, reptiles, and fishes of South Africa; and there also is the cast of the skeleton of the restored triassic reptile, *Pariasaurus bainii*, Seeley. It is also hoped that at some future time other casts and originals of some of these remarkable extinct forms may be exhibited, among which we may perhaps find the progenitors of our modern mammals. The corresponding room is devoted to the general collection of vertebrates. A small room contains the anthropological collection, both South African and general.

two antagonist clans to support—Minamoto or Taira—doubting the accuracy of an oracle given by his patron-god to induce him to serve under the White Banner [*i.e.* the Minamoto clan], caused seven white cocks to combat with seven red ones before the shrine of the same deity. And the result was that the red ones [which represented the Red Banner of the Taira clan] were all defeated by white ones, which impelled him to make up his mind to serve the Minamoto clan" ("Heike Monogatari," tome xi.).

[1] Of allied modes of divination about the decision of a war, I may instance the New Zealander's practice with sticks, and a Gothic king's experiment with swine (see Lubbock, "Origin of Civilisation," 5th ed., p. 245; and Mary Howitt's Appendix to Ennemoser's "History of Magic," ed. Bohn, vol. ii. p. 458).

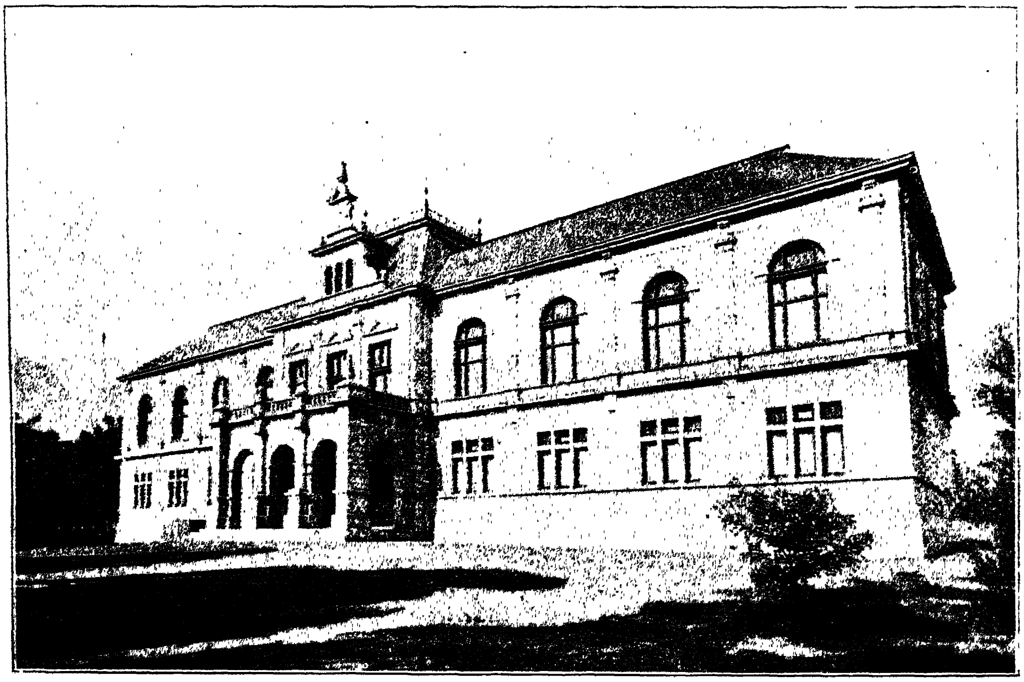
The remaining room is entirely devoted to the South African mammals, among which are an excellent series of antelopes, chiefly obtained for the Museum by Mr. Selous; and the white rhinoceros, which was shot in Mashonaland about two years ago by Mr. Eyre, and was presented to the Museum by the Right Hon. C. T. Rhodes.

The three rooms first mentioned are lighted by windows, and the cases placed at right angles, much in the same fashion as in the larger galleries of the Natural History Museum at South Kensington. The South African mammal room is lighted from above, and the cases extend all round the walls, together with four very large free standing cases arranged in the middle of the room. All the cases are made entirely of iron and plate-glass, on what is generally known as the Dresden system. This was found necessary in consequence of the great difficulty which has hitherto been met with owing to the warping of all woodwork in South Africa, which entirely prevents rooms are fitted with desk-cases, with underlying drawers, also entirely constructed of iron and glass.

The small rooms, together with those underneath the South African mammal room, are the offices, the library, and study-collections in cabinets and preserved in spirit. Apart from the main building is a large taxidermist shop and store room.

Great interest was shown in the recent formal opening of the Museum by the Prime Minister, Sir J. Gordon Sprigg. A long report of the ceremony appeared in the *Cape Times*, and is here abridged.

The Hon. J. X. Merriman, addressing Sir Gordon Sprigg, and those present, said it had fallen to his lot as the senior trustee to ask him to open the Museum. The occasion marked a very important stage in the history of the Museum, and he could wish it had fallen to some one more scientific than himself to sound the praises of the institution. But, in another way, it was fit that he should say a few words, as he was perhaps the only one in the assembly, except Sir Richard Southey, who



The New Museum at Capetown.

wooden cases from being secure from the attacks of insect pests.

On the ground floor, on either side of the entrance hall are two rooms; of these, the larger one on the left contains the invertebrate collections; the smaller, the antiquities. Amongst these latter, there are a certain number of pieces of glass and china of considerable artistic merit, brought to the Cape by the Dutch settlers in the early days; and also one of the so-called post-office stones on which, before any settlement existed, the captains of passing ships used to engrave the dates of their arrival and departure, and notices requesting subsequently-arriving captains to search near by for letters. Similar stones are still occasionally found in the centre of Cape Town, when excavations are made.

The corresponding rooms on the right of the entrance contain the geological collections; the general collection in the larger room, the South African in the smaller. In the latter a special feature will be the exhibition of specimens relating to the gold and diamond industry. These

recollected the Museum in its infancy. When a boy, in the year 1855, he was always interested in going to the Museum. It was due to two gentlemen who had now passed away, Mr. E. L. Layard and Mr. Charles Fairbridge, that the Museum was first founded. It was then put in the old Slave Lodge; and it was mainly owing to their exertions, and to the interest taken in it by Sir George Grey, that the new Museum and Library was built, and that the Museum migrated there, where it remained for a great many years. At first Mr. Layard was the curator; and amongst the trustees who deserved mention were Sir Richard Southey, who only vacated his office on being appointed Governor of Griqualand West, and Sir Thomas Maclear, the Astronomer Royal, who was now dead. The room was found to be totally inadequate to the size of the collection, and after some negotiations with the Government a grant was obtained, and the result they saw in the building they were now going to open to-day.

He thought it would be fitting that he should say a few words as to some of the aims and objects in arranging the Museum in that building. The prevailing idea, he was afraid, was that a museum was a collection of all sorts, and oddments and curiosities; and the name, like the honourable name of professor, had been a good deal brought down; for instance, they had Barnum's

Museum—and he was afraid people were inclined to imagine the Museum to cope with that magnificent receptacle for the bearded woman and the two-headed calf. The aim, however, of this Museum was that it should really be, in a sort of way, the home of research in South Africa; that whatever scientific research there was in South Africa should find its home within the walls of the South African Museum, and that the collections should be so arranged as to illustrate the different branches of scientific research in that country. The Museum was under the general direction of Mr. Sclater, who had thrown himself into his work with a zeal and efficiency which left nothing to be desired. He had taken upon himself the management of the special branch—that of mammalia—the largest animals of South Africa. These were a vanishing class, owing to the rapidity of progress; for the spirit of civilisation was rapidly destroying all these interesting animals, which made South Africa at one time famous throughout the world.

It was sixty years ago since the great naturalist, Darwin, drew a remarkable picture of the mammalia of South Africa. He drew attention to the fact that the mammalia of South Africa were the largest and most numerous in the whole world; and he compared them with the mammalia of Brazil, and showed in what an extraordinary proportion the weight of our animals exceeded that of the South American animals. Now they had got rid of their mammalia here, and were importing frozen meat; and this could hardly be said to be improving nature. Before the mammalia were extinct, it was very desirable that a collection of them should be formed, and they would see a beginning had been made in this direction. Another branch the assistant curator, Mr. Peringuey, had taken under his charge, viz. the important division of entomology, or the study of insects. Some people, little thinking of the important part insects played in the world, smiled, but it was an insect that cost France more than the Franco-Prussian war; it was an insect that formed their most acute political differences in this country. When he ran through the important part that insect-life played, he sometimes wondered how it was possible for man to exist on the face of the earth at the same time. They also had another gentleman working in the same direction as Mr. Peringuey, viz. Mr. Lounsbury, the able entomologist. They wished, however, to make the Museum the home of insect life—though not of live insects.

Dr. Corstorphine was in charge of the geological section of the Museum, which up to the present time had been neglected. Dr. Corstorphine was making good progress, and in connection with that the Geological Commission had its home in the South African Museum. Dr. Purcell, a South African, had set a fine example. After studying in the science schools of Europe, he came out here to spend his life; he was in charge of the invertebrate section; and finally there was Mr. Gilchrist, who had come out as an expert upon fisheries, and who was in charge of the marine section. So that all the branches were fairly well organised, and the scheme, they would admit, was a good one if it could be carried out. For the organisation the greatest thanks were due to his two fellow trustees, whose zeal and energy deserved all praise. On the Board of Trustees he represented the Philistine element, so he could lay no claim to credit for the scheme of scientific research.

Only one thing seemed to be lacking, and that was a very common thing indeed—that was, that they needed funds; they were crippled for want of money. Some of the gentlemen he had mentioned were working simply for the love of science, whilst others were working on a pittance which some of them would not think well to give to their upper clerks. They lamented in this country that they had not some of those liberal men who in America had identified themselves with scientific institutions. Parliament had been liberal enough in these matters, and it afforded him great pleasure in this connection to say that to Sir Gordon Sprigg they had a right to be thankful, because he had always acted to them, he would not say with liberality, because that was not the word to use in connection with public funds, but with a just appreciation which had not always been met with amongst his predecessors. Not only as head of the Government, but as a personality he called upon the Premier to formally open the institution in which they now found themselves.

Sir Gordon Sprigg said he remembered the South African Museum in the year 1858, in which year he first went to that country. From that time to the present, from a public, not from a scientific point of view, he had taken a very great interest in the institution, and it afforded him very great pleasure indeed to declare the Museum open to the public. Those who had had an opportunity of visiting the Natural History Museum at South Kensington would see that the trustees had endeavoured to follow out in every possible way the design of that great institution. After the very interesting speech delivered by Mr. Merriman, which explained the objects of the institution and the designs of the trustees who had brought it to its present condition—something like approaching to perfection—he would not weary them with any further words, but would simply declare the Museum open for the public. At the same time the trustees recognised the fact that they had never appealed to him in vain for funds, and so long as he held his present position they never would appeal to him in vain. From time to time, so long as he held the position he now held, it would always afford him great pleasure to submit to Parliament any proposals submitted to him for consideration.

Dr. Gill said he had been requested by his fellow-trustees to say a word about one who was one of his dearest friends, who worked hard under great difficulties before a liberal—or should he say a wise—Sir Gordon Sprigg arose. He was the one who really bore the burden and the heat of the day, one who under great discouragement persevered in creating the nucleus of the Museum they were now about to see—and that man was Roland Trimen, F.R.S. On an occasion like the present it would be a great mistake if they were to omit the name of one who had done so much for natural history in South Africa. Mr. Trimen laid the foundation of that museum; they all owed him a great debt of gratitude, and they ought to remember it on that day.

THE SCIENCE OF ART.

PERHAPS the learned Dr. Bastian, of Berlin, has appreciated more than any one else that the psychological aspect of anthropology requires far more attention than has yet been devoted to it; the present writer would venture to assert that it is the department of anthropology that most urgently requires students. No doubt the subject is difficult, but the reward will be great. Experimental and observational psychology have received but scant attention in this country, and the psychology of the lower races has been totally ignored by us.

Of late years several anthropologists have studied the origin and modifications of the decorative designs of savage peoples; but only a very few of these have recognised that the tracing out of the history of a pattern or a design is of minor importance compared with the psychological processes that induced the original selection of the motive, and that operated in its subsequent elaboration or simplification. The scientific study of decorative art is a branch of psychology.

The editor of our contemporary *Mind* also appreciates this fact, and so Prof. G. F. Stout has printed a paper on "Evolution and Psychology in Art," by Dr. Colley March, in the October number of that journal. Dr. March accepts the definition of art as given in Dr. Murray's great dictionary: "Art is the application of *skill* to implements of utility, to subjects of taste, such as poetry and dancing, and to works of imitation and design, such as painting, sculpture and architecture." For the sake of convenience, Dr. March divides art into: (1) Artifice, of purely utilitarian intention. (2) Artistic treatment, or the shaping or arrangement of the details, parts, colours or outlines of implements or structures, whether utilitarian or not, so as to "please the eye." (3) Ornament: works of utility are necessary; man is compelled to make things. We understand why, in the making, they should be artistically treated, for the eye has always been accustomed to see outlines that represent the most functionally useful, and utility is always pleasing. It is not quite so obvious why they should become the subject of Ornament. Ornament is a decoration applied to an object which could exist quite well without it. Several examples of every-day objects are given, which show that Ornament sprang from structural handicraft, and became

rooted in the mind by association of contiguity, and that thus an expectancy was raised for them of such urgency that transfer took place as occasion offered. The discussion of this subject takes up the greater part of the paper. (4) Embellishment is finery, which may be sexual, bellicose, proud, aggressive, or wanton, and not unfrequently these articles of embellishment cannot be regarded as examples of Fine Art. (5) The works of Fine Art can be sharply differentiated from Ornament. They have an altogether independent existence, and are not subordinate to serial repetition. It is their aim and end to excite a high order of emotion. If we admit that Fine Art exists solely for the purpose of furthering emotion, we may safely conclude that emotional craving originated it.

"In conclusion," writes Dr. Colley March, "the five elements of Art may be analysed upon an urn. Artifice has moulded a hollow vessel of earth, and has baked it so that it will hold water. As the gourd was in many cases its model, Expectancy has required its base to be much narrower than strict utility might have provided; but the ring that was once a stand for it has now become its foot. Artistic treatment has given it outlines that we, or others, call graceful; has coloured its clay, and washed its surface with a translucent glaze; and has carried aloft in symmetrical curves those handles that were once of ozier or of cords.

"Round the foot and shoulder and neck, Expectancy has drawn bands of Ornament, skeuomorphs [designs derived from technical methods of construction in handicraft] of binding, of basketry, or of textiles; and a phyllomorph [or plant-design] is parasitic upon them. Embellishment has hung a foolish chain in a festoon between the handles. And Fine Art has filled the middle zone with a bas-relief, or a painting, that moves the soul.

> 'What leaf-fringed legend haunts about thy shape
> Of deities or mortals, or of both,
> In Tempe or the dales of Arcady?'

Thus, revealed upon a vase, we witness not alone the elements of Art, but its history, its psychology, and its evolution." A. C. H.

ADAM HILGER.

By the death of Adam Hilger, which took place on April 23, the physical sciences, and especially astronomical physics, have suffered a loss which cannot be immediately made good. Standing in the front rank of practical opticians, he did much to promote scientific progress along various lines, his thorough scientific training enabling him to undertake optical work of the highest character.

Born in Darmstadt, in 1839, he early showed a marked inclination for the mechanical work in which his father was then engaged. For some years he was a mechanical engineer in Darmstadt, and he afterwards entered Ertel's famous establishment at Munich. He next came to London, but, though commanding a good salary, he found no opportunity of advancing his knowledge, and soon left for Paris, where he had the good fortune to find employment with the firm of Lerebours and Secretan. During this engagement he constructed many instruments, under the direct supervision of Foucault, and became fully acquainted with the theory, as well as with the practice, of his art. After the war of 1870 he came to London with his family. Here he was engaged with Mr. Browning, at first as a simple workman, but afterwards as foreman. Having completed a five years' contract, he commenced business on his own account at Islington. At these well-equipped works he produced the instruments which have brought him such a high reputation among physicists and astronomers throughout the world. He was especially skilled in manipulating quartz and Iceland spar for work on the ultra-violet rays, and had lately succeeded in making very perfect achromatic combinations of these materials. The special qualities of the new Jena glasses were also well known to him, and by their use he produced achromatic lenses of very short focal length, as well as prisms of very high dispersion.

We understand that the business will be, in all probability, continued by Mr. Otto Hilger. A. F.

A NIGHT IN MID-MAY.

NOW tender eve has kissed the drooping eyes
Of sleeping daisies; incense floods the air,
Bowed Nature kneeling at her vesper prayer;
Mid rustling leaves the pensive night breeze sighs.
In heaven's great garden brighter flowers arise;
While throned Arcturus fires the southern skies;
Aglow the coils of Berenice's Hair;
Her wonted path the patient moon makes fair.
Calm whisperers! of splendours far away,
Glad messages in golden light ye bring—
A heart's desire fulfilled one happy day,
In perfect love and never ending spring,
Where painless pleasure shall no more take wing,
Nor spectral winter close the eyes of May.

M. C. L.

NOTES.

THE Bakerian Lecture will be delivered at the Royal Society on Thursday next, May 20, by Prof. Osborne Reynolds, F.R.S., and W. H. Moorby. The subject will be the mechanical equivalent of heat.

DR. E. J. STONE, F.R.S., Radcliffe Observer at Oxford, died on Sunday last. Astronomy has thus lost one of its foremost workers.

WE join in the general expression of regret at the death of the Duc d'Aumale, a very distinguished member of the French Academy. He spent a great part of his life in England, and received the honorary D.C.L. at Oxford in 1891. He frequently appeared at the Athenæum Club, and his interesting personality was therefore known to many who were not his fellow-countrymen. By a deed of gift, executed in 1884, the Duc d'Aumale's château at Chantilly, and all its precious contents, was presented to the Institute of France, in trust for the French nation, subject only to his life interest in the château. The Paris correspondent of the *Times* gives particulars of this splendid gift. By the terms of the bequest Chantilly must preserve the character of a museum. The exterior wings are assigned as lodgings for the three curators, and the museum, under the supervision of the Institute, will be an institution open to the public. Besides this, the Institute, to meet the expense of the preservation of Chantilly, is given the forest, the annual clearings in which produce about 100,000 francs. It also possesses other portions of the estate, which will produce more than the sum necessary for the maintenance of a museum. France will thus always possess a magnificent monument to the memory of one who held national welfare very dear.

THE annual conversazione of the Society of Arts will be held at the South Kensington Museum, on Wednesday, June 16.

THE Yachting and Fisheries Exhibition at the Imperial Institute will be opened by their Royal Highnesses the Prince and Princess of Wales, on Monday, May 17.

THE *Lancet* states that the Government of India, recognising the arduous and valuable nature of M. Haffkine's recent work in connection with the bubonic plague, has sanctioned the grant of a monthly salary of Rs. 2000 to him instead of the

allowances hitherto given. This arrangement is to have a retrospective effect from the date on which he began work in Bombay.

THE Committee of the Puffin Island Biological Station have decided to offer facilities to students and others for the pursuit of scientific research at the station during the summer months. The island is well situated for the study both of marine zoology and ornithology, and the station is provided with sleeping accommodation in addition to the usual laboratories. Those wishing to avail themselves of the present opportunity should communicate with the Director, Prof. P. J. White, University College of North Wales, Bangor.

AT the annual meeting of the Institution of Civil Engineers, recently held, the Chairman was able to announce some important changes which have recently been made in the management of this Society, which are calculated to bring its proceedings more up to date. Hitherto, new members and associates have been admitted on a kind of guarantee, signed by a certain number of existing members, that the applicant is, by training and experience, duly qualified to act as a Civil Engineer; and although in recent years the Council have taken steps to ascertain that the candidate has been properly educated, no direct examination has been required. In future, in addition to the requirements now in force, a test examination of the general and scientific knowledge of candidates for election into the class of associate members will be required. A further departure from old customs, which has also recently taken place, is that members can now vote for the annual election of the President and Council by balloting papers, without personal attendance at the meetings, as used formerly to be necessary. The roll of members of this Institution now numbers 6204, and is constantly on the increase. The last year's annual income amounted to 22,285*l*. A large amount out of the capital funds belonging to the Society has recently been expended on the new building in Great George Street.

WE regret to announce the death, on the 7th inst., of Mr. Abraham Dee Bartlett, the well-known resident Superintendent of the Zoological Society's Gardens in the Regent's Park. Mr. Bartlett was born in London in 1812, and was formerly in business as a dealer in natural history specimens. After a short period of office as head of the Natural History Department at the Crystal Palace when it was instituted, Mr. Bartlett was appointed Superintendent of the Zoological Gardens in 1859, shortly after Mr. Sclater became Secretary, and continued in the efficient performance of his duties until about six weeks before his decease. In his practical knowledge of living animals Mr. Bartlett was unrivalled, especially as regards mammals and birds. No one knew better than he whether an animal offered for sale was sound or sick, or was a better judge of its value. He was also an excellent observer of the habits and structure of the animals under his charge, and communicated many valuable papers to the Zoological Society's scientific meetings on these subjects. One of the most remarkable of these was that on the shedding of the horns by the Prongbuck (*Antilocapra americana*), published in 1865. Mr. Bartlett's discovery of this curious phenomenon was at first discredited by the American naturalists, but the fact is now universally admitted.

THE death is announced of Mr. Matthew Carey Lea, of Philadelphia, at the age of seventy-four. From an obituary notice in the *American Journal of Science* we derive the following particulars of his work:—"Mr. Carey Lea was elected a member of the National Academy of Sciences in 1892, and the list of his more important papers then published contained fifty-four titles. These investigations for the most part related to the chemistry of photography, and especially to the action of light and other forms of energy upon silver salts. He described photo-bromide and photo-iodide of silver, and in 1887 published a paper on the 'Identity of the photo-salts of silver with the material of the latent photographic image.' His most remarkable discovery, however, made in 1889, was that silver is capable of existing in three allotropic states. The first is allotropic silver proper, 'which is protean in its nature, may be soluble or insoluble in water, may be yellow, red, blue or green, or may have almost any colour, but in all its insoluble varieties always exhibits plasticity; that is, if brushed in a pasty state upon a smooth surface, its particles dry in optical contact and with brilliant metallic lustre. It is chemically active.' The second is intermediate in character, may be yellow or green, always shows metallic lustre, is never plastic, and is chemically indifferent. The third is ordinary silver."

WITH much regret we have to announce the death, on May 5, of Mr. J. Theodore Bent, who had just returned from a journey, with Mrs. Bent, in Sokotra, and in southern Arabia, in the course of which they had made some remarkable discoveries. Both had suffered from malarial fever, and Mr. Bent succumbed to a subsequent attack of pneumonia. For twenty years Mr. and Mrs. Bent spent a large part of each winter in travelling, and their later journeys have been described in several books. The more important were those in Greece and Asia Minor, in the course of which Mr. Bent acquired remarkable facility in modern Greek, and established his reputation as an archæologist; in the Bahrein Islands of the Persian Gulf; in Mashonaland, where he was the first to systematically study the wonderful ruins of Zimbabwe; in Abyssinia; on the Red Sea coast of Egypt; and to Hadramut, in southern Arabia. A leading object in the later journeys was to investigate the extension of the Sabeans at the period of their prosperity as a trading nation. Mr. Bent read many important papers to the Royal Geographical Society, the British Association, and other Societies. His unique collections of antiquities have been exhibited at the Royal Society's conversaziones, and his gatherings from numerous wanderings made his house a veritable museum. While his death is a serious loss to archæology and geography, the personal sorrow which it occasions is greater than in the case of most explorers. Mr. Bent had a very large circle of devoted friends, which, with a frank kindliness peculiarly his own, he was ever widening. The unaffected heartiness of his manner to all, and his readiness to assist every one engaged in kindred studies, will not soon be forgotten. Although he died at the age of forty-five, Mr. Bent leaves behind him the memory of more kind actions and helpful words than can be placed to the credit of most men whose lives have ripened into old age.

THE new Ostrich-and-crane-house in the Zoological Society's Gardens has lately been completed, and is already fully tenanted. The compartments on the south side accommodate all the struthious birds, which have now for the first time been brought together from different parts of the Gardens. The most recent addition is a fine adult male of the Somali ostrich (*Struthio molybdophanes*), remarkable for the bluish tinge of the naked parts, which in the Northern ostrich are red. The sixteen compartments on the north side are occupied by a fine series of cranes and storks.

THE anniversary meeting of the British Ornithologists' Union was held in the Zoological Society's Offices, 3 Hanover Square, on the 5th inst.; Mr. P. L. Sclater, F.R.S., in the chair. The report of the Committee gave a very favourable account of the Union's affairs, and of the progress of its journal, the *Ibis*, which has now been carried on successfully for thirty-eight years. Twenty-four new members were elected, raising the strength of the Union to more than 300. For the ensuing

year Mr. F. D. Godman, F.R.S., was elected president, and Mr. O. Salvin, F.R.S., secretary, the editors of the *Ibis* (Messrs. Sclater and Saunders) remaining as before.

THE first of a series of ten lectures, on the structure and distribution of birds, was given at the Zoological Society's Gardens on May 6, by Mr. F. E. Beddard, F.R.S., prosector to the Society. The lecture dealt with the main points in the external and internal anatomy of the class, special weight being laid upon those characters which are associated with the flight of birds. The lecturer gave a short *résumé* of the characters of the feathering of birds, not omitting to mention that, at present, baffling problem—the presence or absence of the fifth cubital remex. Attention was directed to the fact that although, on theoretical grounds, a continuous feathering, like that of the penguins and struthious birds, was to be looked upon as the primitive state of affairs, it was doubtful whether, in existing birds, the close feathering was not a secondarily acquired character. In support of this, the transitory existence of marked apteria and pterylæ in the chick-ostrich, as first described by Miss Lindsay, was pointed out. In describing the essential features of the skeleton, the lightness of the bones, the massing of the chief weight in the middle of the body, the structure of the hand, and various matters illustrative of the adaptation of that part of the organism to the purposes of flight, were dwelt upon.

PROF. HANKIN'S report to the Bombay Chamber of Commerce, concerning the infection of grain and the vitality of the bacillus of plague in infected grain, is thus summarised in the *British Medical Journal*. (1) The microbe has not been found in either stored grain or in parasitic insects inhabiting grain. (2) Grain can be infected by a pure culture of the bacillus of plague, so that an extract made therefrom will cause death from plague in animals (mice). (3) The potency of grain-infected extract rapidly diminishes, so that in a few days it does not kill. Thirteen days is the extreme limit of possible potency; but Prof. Hankin is led to the belief, by his experiments, that plague bacilli obtaining admission to grain stored as on board ship would certainly become non-infective in four to six days.

THE definition of a standard or standards of thermal efficiency for steam-engines was referred to a Committee of the Institution of Civil Engineers last year; and the gist of the conclusions, which have just been arrived at, is as follows: (1) That the statement of the economy of a steam-engine in terms of pounds of feed-water per horse-power per hour is undesirable. (2) That for all purposes, except those of a scientific nature, it is desirable to state the economy of a steam-engine in terms of the thermal units required per horse-power per hour (or per minute), and that if possible the thermal units required per brake horse-power should also be given. (3) That for scientific purposes the thermal units that would be required by a perfect steam-engine working under the same conditions as the actual engine should also be stated. The proposed method of statement is applicable to engines using superheated steam, as well as to those using saturated steam, and the objection to the use of pounds of feed-water, which contain more or less thermal units according to conditions, is obviated; while there is no more practical difficulty in obtaining the thermal units per horse-power per hour than there is in arriving at the pounds of feed-water. For scientific purposes the difference in the thermal units per horse-power required by the perfect steam-engine and by the actual engine shows the loss due to imperfections in the actual engine. It is pointed out that a further advantage of the proposal is that the ambiguous term "efficiency" is not required.

IN the *Mittheilungen der K. K. geographischen Gesellschaft*, in Vienna (vol. xl. Nos. 1 and 2), there is an exhaustive memoir on the Karlseisfeld or Hallstätter Glacier of the Dachstein. The first part is devoted to a minute examination of the topography of the region, and the second to an account of the methods and results of a careful survey made by the author. An excellent map is appended.

THE current number of *Petermann's Mittheilungen* contains the first instalment of a new estimation of the areas of non-European river-basins, by Dr. Alois Bludau. The numbers for South America are here given. Sixteen separate basins make up a drainage area of 16,275,000 square kilometres to the Atlantic; the Pacific slope, divided into four regions, accounts for 1,056,000 square kilometres; leaving the Titicaca and similar regions, without an outlet to the sea, the remaining 274,000 square kilometres.

WE have received from the author a contribution to the rapidly increasing literature of limnology—"Zur Entstehung der Alpenseen," by Dr. L. Swerinzew. Dr. Swerinzew criticises a good deal of recent work somewhat severely, and comes to the conclusion that a number of the types of lake-basins now regarded as different, are really identical as regards their mode of origin and development. About 90 per cent. of the Alpine lakes found in valleys are held to have been formed simply by the erosive action which gave rise to the valleys themselves.

M. DE LAPPARENT contributes to *La Nature* a note on some further considerations suggested by Nansen's discovery of a deep Arctic basin. He points out that the area we may now assign to the Arctic Ocean is almost the same as that given by Murray to the Antarctic Continent—about four and a half million square kilometres, while the depths observed by Nansen correspond in order of magnitude to the heights observed by Ross; and it is remarkable that a small area like the Arctic Ocean should give soundings equal to the averages obtained in the Atlantic and Pacific. These considerations, similar to those which have led Mr. Lowthian-Green to assume that the earth has a tetrahedral form, suggest that it may really be top-shaped, the spinning point, as it were, being the South Pole. Such a supposition would tend to reconcile the differences of astronomers and geodesists as to the ratio of the polar and equatorial diameters; for the latter base their value of the polar flattening, 1/294, upon measurements made almost entirely in the northern hemisphere. The value obtained by M. Tisserand from the precession of the equinoxes, 1/297, may be found sensibly correct, if the existence of the south polar protuberance, and consequent effects upon the form of the sea surface, are admitted.

SINCE the great earthquake of 1855, the strongest felt in Tokio was that of June 24, 1894, which forms the subject of a valuable paper contributed by Prof. F. Omori to the Italian Seismological Society. The entire land-area disturbed was about 110,000 square miles. The meizoseismal area was a band lying to the east of Tokio, and running north and south, from Iwatsuki to the Bay of Tokio. This band occupies the lowest part of the plain of Musashi, which is the continuation of the axis of the bay, and the earthquake was probably connected with a long fault lying beneath the meizoseismal band. Records of the earthquake were obtained at two observatories in Tokio. At one of these, situated on high and hard ground, the earthquake consisted of one prominent oscillation, preceded and followed by smaller vibrations; the maximum horizontal displacement being 73 mm. in the direction S. 70° W. and N. 70° E., and the maximum horizontal acceleration 444 mm. per sec. per sec. At the other observatory, which is on low and soft ground, the horizontal displacement was 130 mm., and the maximum acceleration about 900 mm. per sec. per sec. Prof. Omori believes that near the epicentre of a great earthquake, the movement is generally of the same simple character

as that above described, combined with a definite direction of the shock. Slighter earthquakes usually consist of a great number of small vibrations of nearly equal amplitude executed in different planes.

THE method of the computation of the Chinese calendar is described with clearness by Paul d'Enjoy in the *Bulletins de la Soc. d'Anthropologie*, 1896, p. 562. Every year is named by a combination of two words according to a fixed rule, and the special combination is supposed to indicate the fortunes of the year. The year 1896 was the period of the external hearth and the monkey; that is a time of dangers from abroad, which must be met by cunning and dexterity. Unfortunately for the Chinese, it was the Japanese that exhibited these qualities! In 1897 the Chinese enter calmer times, under the auspices of the internal hearth and the chicken. Next year the activity of the nation will be diverted from the cultivation of the soil, and turned towards watchfulness and the protection of the home, as the yearly combination is waste-land and dog. The months, weeks, days and hours are also described. Each of their hours corresponds to two European hours, of which seven belong to the day, and five to the night; the first hour commences at 11 o'clock at night. M. d'Enjoy states that Belgium is about to adopt the principle of the Chinese double hours for the official railway time-tables.

WHAT Sir William Flower has to say upon "Natural History as a Vocation," carries great weight; so parents with children who have proved the earnestness of their interest in nature's life and moods, should turn to an article in *Chambers's Journal* (May) if they wish to know exactly what are the prospects of the livelihood obtainable by following the inclination. "As to natural history as the regular occupation of one who has no other means of living," says Sir William Flower, "I have little to say that is favourable, as it is about the worst paid and least appreciated of all professions." There are signs, however, that the prospects are brightening, and the youth who feels confident of his ability "to scorn delights and live laborious days," may eventually find his way to a position as a lecturer, demonstrator, or curator. To pursue the vocation with any chance of success, he must have a considerable knowledge of modern languages and other subjects, as well as of natural history. He should begin wisely to collect specimens, and should educate himself by his collection; for, Sir William Flower points out, "The arrangement of a collection not only teaches the nature and properties of the objects contained in it; it also stimulates a desire to know more of the similar objects not contained in it, but to be found in other and larger collections. Still more important than this, as an educator, it calls out many valuable practical qualities: originality, order, neatness, perseverance, taste, power of discriminating small differences and resemblances, all of which will be found useful in other spheres of life." Sir William Flower's first "museum" was contained in a large, flat, shallow box with a lid; and one of the first specimens he possessed was a badly stuffed specimen of the dipper or water ousel.

IN the *American Journal of Mathematics*, xix. 3, Dr. G. H. Bryan gives a brief account of certain applications of the theory of probability to physical phenomena. The main difficulty in accounting for such phenomena by means of the principles of theoretical dynamics lies in the fact that the equations of motion of an ideal system always represent reversible processes, which in nature are conspicuous by their absence. The author proceeds to examine how far the difficulty may be overcome by introducing the theory of probability, especially in connection with the kinetic theory of gases, and he gives a short *résumé* of certain investigations by Prof. Boltzmann, from which it is found that, under certain assumptions, the most probable distribution of the coordinates and momenta of the molecules of a gas is that which has been termed the Boltzmann-Maxwell distribution. Unfortunately, however, the proofs involve certain initial assumptions, and, on varying the nature of these, the results as to the most probable final distribution will be different. It would thus appear that even probability considerations do not afford unassailable proofs of the law which forms the usually accepted basis of the kinetic theory—a result completely in accordance with Mr. Burbury's recent investigations, according to which assemblages of densely-crowded molecules do not conform to that law.

FROM a number of papers before us dealing with kathodic and Röntgen rays, we extract the following. Dr. Garbasso (*Nuovo Cimento*, 4, iii.), in discussing the effects of products of combustion on the length of the electric spark, considers that if flames produce certain actions on the sparks, like those of Röntgen rays, it is because they are the seat of chemical phenomena, since in the products of combustion there exist dissociated molecules, in other words electrified particles. It seems probable that Röntgen rays and ultra-violet light act on sparks for the same reason.—Dr. Quirino Majorana (*Atti dei Lincei*, vi. 5) discusses the electrostatic deviation of kathodic rays, such as can be studied by the introduction of a second kathode or anode in the discharge-tube.—M. L. Benoist (*Bulletin de la Société Française de Physique*, 91) has attempted to discover the law of transparency of substances for Röntgen rays. Defining the *specific absorbing power* as the absorption produced by a layer of unit surface density (or of 1 decigramme per square centimetre), M. Benoist finds that for ordinary rays this power increases with the density, but the results vary with the quality of the rays themselves. The author advances the view that the law of density (according to which the specific absorbing powers of all substances are equal) is a kind of *limiting* law towards which the results of observation tend as rays of higher frequency are produced.—M. Jean Perrin, in discussing the laws according to which electrified bodies are discharged (*Bulletin de la Société Française de Physique*, 93) considers that when the rays actually reach the conductor, two separate factors must be taken into account, viz. the "metal effect" produced by the incidence of the rays on the conductor, and the "gas effect" due to their action when traversing the gas. By considering the two terms separately, the law of discharge can be represented by a simple mathematical formula.—M. Désiré Korda, in the same number of the *Bulletin*, calls attention to a remarkable dissymmetry produced by Röntgen rays in vacuum tubes, and which he has observed in experiments undertaken in conjunction with Dr. Oudin.

WE have received a report of the results obtained from the experimental fields for the cultivation of the sugar-cane in Antigua, by Mr. F. Watts and Mr. F. R. Shepherd. The experiments were mainly on the advantages to be derived from the use of mineral manures in the cultivation of the cane. The remarkable and unexpected result was obtained that the addition of phosphates to the soil diminishes the yield of sugar. Nitrogen, in the form of ammonium sulphate, sodium nitrate, or dried blood, has a slightly beneficial effect on the yield; potash a much greater beneficial effect.

THE Report of the Kew Observatory Committee for the year 1896 states that the magnetic curves during the past year have been quite free from any very large fluctuations. The earthquake of December 17 was shown slightly on the Declination curve, but more distinctly on the Horizontal Force curve. The mean Westerly Declination for the year was 17° 10'·8,

and the mean Inclination 67° 22′·3. In the various experiments carried on at the observatory, particular attention has been paid to observations of atmospheric electricity, and to the comparisons of mercury and platinum thermometers. The number of instruments verified during the year exceeded 20,500.

M. Camille Flammarion brings together (*Bulletin de la Société Astronomique de France* for May) some statistics regarding the amount of rainfall in Paris since the year 1688, which discloses the remarkable fact that a gradual increase in the fall for the last two hundred years is indicated. A glance at the yearly means does not, perhaps, give such a decided apparent increase as a survey of the means obtained by grouping several years together. The following brief table, extracted from M. Flammarion's note, speaks for itself:—

	mm.
1689 to 1719	485·7
1720 „ 1754	409·4
1773 „ 1797	492·5
1804 „ 1824	503·7
1825 „ 1844	507·5
1845 „ 1872	522·4
1873 „ 1896	557·4

Whether this "increase" is actually due to more rain, or to some such causes as better positions for rain gauges, or more improved rain gauges themselves, one cannot with certainty say, but the amount of increase seems rather to negative this. The figures, nevertheless, are very astonishing; and it would be interesting to examine other series of observations extending over a long period.

The Geological Commission of Cape Colony has published a bibliography of South African geology, containing a list of nearly six hundred papers.

Astronomers will be interested to know that Mr. Henry Frowde has in hand "Tables for Facilitating the Computation of Star-Constants," by Dr. E. J. Stone, F.R.S., Radcliffe Observer at Oxford, modified and revised by Pr . H. H. Turner. We much regret to have to add to this announcement that Dr. Stone died on Sunday last.

In papers recently published in the *Bulletin* of the American Museum of Natural History (November 1896 and March 1897), Dr. J. L. Wortman makes an important contribution to the knowledge of Mammalian descent. He unites six genera of primitive Mammalia, from various horizons in the North American Eocene, into a sub-order Ganodonta, and maintains that they are the ancestors of the New World Edentates. In following one of the families of this sub-order up through successive stages of the Eocene, he finds the genealogy to be completely traceable; at the end of that period the line disappears altogether, but is taken up again in the Edentates of the Santa Cruz formation of South America. An almost inevitable conclusion from this is that about the end of the Eocene there was at least a temporary land connection between the two Americas.

Messrs. John Walker and Co., Ltd., have sent us several packets of their "Perfection Envelope," which have been designed to do away with the necessity of licking, or otherwise moistening, the gum on the flap of an envelope in order to make it adhere. The gum is placed upon the back of the envelope instead of on the flap, so that by moistening the flap the envelope can be sealed without touching the gum with the tongue. The advantage thus gained is not very clear, for it is possible in the case of any envelope to moisten the back instead of the gummed flap. What is really required is a simple device for sealing envelopes without going through the very objectionable practice of licking them.

A second edition of Prof. Lester F. Ward's "Dynamic Sociology, or Applied Social Science, as based upon Statistical Sociology and the less Complex Sciences" (two volumes) has been published by Messrs. D. Appleton and Co. The work first appeared in 1883, when there was not a chair of Sociology in any University in the world. Now there is a small army of active professors of Sociology in the United States alone, and the demand has consequently arisen for a new edition of Prof. Ward's pioneer work. Very little revision has, however, been made. An amusing story is told by Prof. Ward with reference to his volume. The book was interdicted in Russia, but the grounds upon which the action of the Russian Government was based were not clear until a correspondent suggested that the cause of trouble was the title, which appeared to be "a compound of *socialism* and *dynamite*."—A second edition of Dr. L. Edmunds' "Law and Practice of Letters Patent for Inventions" has been prepared by Dr. T. M. Stevens, and is published by Messrs. Stevens and Co. The first edition of the book appeared in 1890, and was reviewed in our columns in that year (vol. xliii. p. 53).—Prof. E. A. Schäfer's very instructive "Course of Practical Histology" (Smith, Elder, and Co.) has reached a second edition. The volume is a practical handbook in which practicable methods are described. Its aim is "to assist the student to carry on histological work independently of the constant presence of a teacher"; and well is this purpose realised throughout the book. —Messrs. E. and F. N. Spon have published a third, considerably enlarged, edition of "The Engineer's Sketch-Book," by Thomas W. Barber. The work contains 2603 sketches of "mechanical movements, devices, appliances, contrivances and details employed in the design and construction of machinery for every purpose, classified and arranged for reference for the use of engineers, mechanical draughtsmen, managers, mechanics, inventors, patent agents, and all engaged in the mechanical arts."

Among noteworthy papers and other publications which have come under our notice within the past few days are the following:—Dr. Fridtjof Nansen contributes to the *Geographical Journal* (May) a valuable outline of the scientific results obtained during the Norwegian Arctic Expedition. The same journal contains a full report of the discussion of the North Polar problem, at the Royal Geographical Society on March 22.—Mr. J. Holt Schooling illustrates "The Weight of the Earth" with several ingenious diagrams in the *Strand Magazine*.—Three books, by Prof. C. Lloyd Morgan, referring to the human mind and animal intelligence, furnish the text for an article in the *Quarterly Review* (No. 370, April).—Two papers on the structure and physical characters of striped muscular fibre, and the phenomena of its construction, appear in the *Journal of Anatomy and Physiology* (April), and form useful contributions to a subject which has for many years furnished histologists and physiologists with material for controversy.—The notes on progress in petrography, contributed during 1896 to the *American Naturalist*, by Mr. W. S. Bayley, have been brought together in a pamphlet, which should prove very serviceable for reference.—In the *Proceedings* of the Royal Society of Victoria (vol. ix.), containing papers read before the Society during 1896, are described: A new species of marsupial from Central Australia; aboriginal rock painting in the Victoria Range, County of Dundas, Victoria; geographical distribution of land and fresh-water vertebrates in Victoria; the temperatures of reptiles, monotremes and marsupials; the "Burbung" of the New England Tribes, New South Wales, and the "Bora" of the Kamilaroi Tribes (these detailed descriptions of ceremonies of Australian native tribes are based upon personal observations made by the author, Mr. R. H. Mathews); a contribution to the knowledge of the Tertiaries in the neigh-

bourhood of Melbourne; and the values of the wave-lengths of the spectrum lines of the alkalies, as determined by a new periodic formula.—A discourse pronounced by the late Dr. du Bois-Reymond in honour of the memory of Hermann von Helmholtz, is now published by Veit and Co., Leipzig. The discourse is a full and valuable statement of Helmholtz's life and scientific work.

THE additions to the Zoological Society's Gardens during the past week include an Orang-outang (*Simia satyrus*, ♀) from Borneo, presented by Lord Ashburton and the Earl of Crawford; a White-crowned Mangabey (*Cercocebus æthiops*, ♀) from West Africa, presented by Mr. Bernard A. Collins; a Malayan Bear (*Ursus malayanus*, ♀) from Malacca, presented by Lord and Lady Ashburton; a Nightingale (*Daulias luscinia*), British, presented by Mr. W. H. St. Quintin; three Common Boas (*Boa constrictor*) from the Teffe River, Upper Amazons; a Brazilian Tortoise (*Testudo tabulata*) from Brazil, presented by Mr. H. C. Fernando Rohé; a Phayre's Tortoise (*Testudo emys*) from Borneo, presented by H.H. the Tuan Muda of Sarawak; a Forsten's Lorikeet (*Trichoglossus forsteni*) from Sumbawa, a Blue-faced Lorikeet (*Trichoglossus hæmatodes*), two Perfect Lorikeets (*Psitteuteles euteles*) from Timor, a Phayre's Tortoise (*Testudo emys*) from Borneo, deposited; a Malbronck Monkey (*Cercopithecus cynosurus*, ♂) from Congoland, two Phayre's Tortoises (*Testudo emys*) from Borneo, two Long-tailed Grass-Finches (*Poëphila acuticauda*) from North-west Australia, purchased.

OUR ASTRONOMICAL COLUMN.

MAY METEORS.—During the month of May the number of meteors is by no means considerable, the records showing quite a dearth of deduced radiant points at this season of the year. One, however, which seems to be, to some extent, prominent (*Astr. Nach.*, No. 3418), is that which is situated in the region near the brightest star in Corona. The Greenwich observers in 1866 one evening recorded no less than seven first magnitude meteors, and five fainter ones, in the course of an hour; and Mr. Denning tells us that he himself made some very successful observations in 1885. This observer is of opinion that previous observations indicate the occurrence of a special shower, and he gives, as a mean of many determinations of the positions of radiant points, the coordinates $232°\cdot8 + 28°\cdot6$. May 18 is given as the day on which special attention should be devoted to this shower.

CENTRALSTELLE TELEGRAMS.—We have received a communication from Prof. H. Kreutz, in Kiel, which informs us that he has taken over definitely the direction of the Central Bureau for astronomical telegrams, and that in future the telegraphic address will *not* be Bureau der Centralstelle, Koniglichen Sternwarte, Kiel, but Astronomische Centralstelle, Kiel. Prof. Kreutz also incloses the "Statutes" of the Centralstelle, which have been recently revised.

ACCIDENTAL ERRORS OF TALCOTT OBSERVATIONS.—From a series of observations, 500 in number, made with the object of determining the latitude of Hong Kong, Herrn Doberck (*Astr. Nach.*, No. 3418) states some interesting facts about the choice regarding magnitude of stars that will be useful to observers using the Talcott method. It has been previously found that neither the zenith distance, nor the amount of the difference of zenith distance, if within 10′, affects the error of the results; neither is the difference of right ascension, if less than 20 m., affected. Herrn Doberck suggests that these limits might with advantage be extended: it is better to "observe bright stars with zenith distance greater than 20°, difference of right ascension greater than 20 m., and difference of zenith distance greater than 10′, than to observe fainter stars within these limits, as the accidental errors of observation increase when the brightness of the stars decreases." Taking the average magnitude of each pair of stars from 3·5 magnitudes up to the 7th magnitude, he gives a table showing the probable errors of one observation for each increase of half a magnitude.

FURTHER STUDIES ON SNAKE POISON AND IMMUNITY.

PROF. CALMETTE, whose name is so indissolubly associated with the study of snake bites and their treatment by anti-venomous serum, has lately published in the *Pasteur Annales*, in conjunction with his assistant M. Delarde, a most interesting and highly important series of experiments helping to elucidate the mechanism of immunity. Endeavouring to throw light upon some of the problems surrounding this highly complex question, Calmette has selected two different kinds of toxin, the one vegetable and the other animal.

The vegetable toxin was furnished by the substance known as abrine, which is the active principle of the seeds or beans of *abrus precatorius*, a leguminosa common in India and South America. It is a highly toxic material, and one milligramme suffices to kill a rabbit in forty-eight hours. Very few animals apparently can resist its action, and so far as Calmette's observations go, this immunity is restricted to hedgehogs, fowls, tortoises, snakes (*couleuvres*) and frogs. It requires as much as ten milligrammes of abrine to destroy either a hedgehog or a fowl in forty-eight hours, whilst a tortoise only succumbs after a dose of thirty milligrammes.

The animal toxin selected for these experiments was, as might be expected, serpent venom, consisting of a mixture of venoms derived from various kinds of poisonous snakes.

In the course of his previous researches, Dr. Calmette was led to believe that snakes had a charmed life against all injections of serpent venom; but he now tells us that his earlier conclusion requires correction. He has succeeded in killing Egyptian asps and a serpent native to Indo-China by injecting doses of venom three times as great as that normally present in their respective poison glands, and he is, therefore, of opinion that although reptiles do possess great powers of resisting the toxic effect of serpent venoms, yet, contrary to what he at first supposed, their immunity to this poison is not absolute.

Various hypotheses have been suggested to account for this comparative immunity exhibited by reptiles to the effect of venom, and Prof. Fraser, of Edinburgh, has attributed this phenomenon to the presence in the blood of reptiles of some anti-toxic substance. Calmette, however, has shown that, far from protecting animals from the toxicity of venom, reptile blood causes their death. Experiments in this direction were not only made with the blood derived from the liver and other organs of a *naja tripudians*, but also with injections of a filtered aqueous emulsion of these organs, but in no case was any protective action recorded.

Again, the serum of pigs, which animals in some countries are specially trained for the purpose of hunting serpents, which they devour greedily without suffering the least inconvenience from their bites, the serum of these animals has no modifying action whatever outside the body, *in vitro*, on serpent venom, and has no protective action.

Similar experiments were also made with animals exhibiting a relative immunity to the toxic action of the vegetable poison, *i.e.* abrine. It was found that whereas the normal serum of hedgehogs, which animals possess a natural immunity to abrine poisoning, can protect other animals susceptible to this toxin from its lethal effects, yet to do so effectually large quantities of the serum in question must be employed. On the other hand, fowls and tortoises, although also naturally immune to the abrine toxin, can confer, by means of their serum, no protective power whatever upon other animals against this poison.

The next question approached by Calmette was whether these so-called refractory animals can elaborate anti-toxins, and in the course of his experiments on this subject he obtained some very curious results.

For these investigations abrine only was employed, and profiting by the fact that fowls and tortoises had proved very refractory to this toxin, these animals were chosen as subjects for the inquiry.

Two fowls were given, in the course of twelve days, about eight milligrammes of abrine. Whilst, as we have seen, ordinary fowl-serum can confer no immunity from the effects of abrine poison, the serum derived from the abrine-treated fowl was possessed of immunising properties. In this case, therefore, a refractory animal, normally incapable of yielding an anti-toxic serum, had been trained by artificial means to do so. Similar experiments made with another refractory animal gave, however, quite different results, for when tortoises were treated with abrine poison, instead of their serum acquiring any protective

property, it killed those animals into which it was injected, and by no amount of artificial training could their serum become endowed with any immunising effect. Exactly similar results were obtained with frogs, and whilst the normal blood of these animals was repeatedly proved to be quite devoid of all toxic action on mice, yet after the frogs had been inoculated with abrine, and trained to acquire an immunity beyond their brother frogs towards this substance, their blood invariably killed the mice into which it was injected. Dr. Calmette concludes from these observations that natural immunity to a particular toxin does not imply the existence of a specific anti-toxic substance in the blood of such refractory animals, and that whilst apparently warm-blooded abrine-refractory animals can be trained to elaborate anti-toxins, cold-blooded abrine-refractory animals cannot produce such anti-toxins in the normal conditions of their existence. The latter portion of this generalisation receives some support from Metchnikoff's observations of the same phenomenon in the case of tortoises and tetanic-toxin.

Prof. Calmette next proceeds to discuss the properties of serum derived from those animals in which the immunity to a particular toxin is not natural, but has been artificially induced. We are again for this purpose taken back to anti-venomous serum, and some additional information is given incidentally of the wonderful efficacy which characterises this remarkable remedy for snake bites. Perhaps one of the most astonishing properties of this serum is the rapidity with which it operates. Thus if two cubic centimetres of anti-venomous serum be inoculated into the marginal vein of a rabbit's ear, it at once confers upon the latter immunity towards snake poison. Immediately after the injection of the serum, venom sufficient to destroy an ordinary rabbit in a quarter of an hour may be injected with impunity into the vein of the other ear. Its degree of therapeutic efficiency is also extraordinarily intense, as is well illustrated by the following experiment: four rabbits are inoculated with a quantity of venom sufficient to destroy them in two hours; one of these is left, whilst the other three receive, one hour and three-quarters later, an intravenous injection of serum equal in quantity to one four-hundredth part of their weight. Whilst the unprotected rabbit dies in two hours, the other three remain in perfect health. "Voilà donc un sérum qui," writes Calmette, "d'emblée, sans reaction préalable de l'organisme, produit l'insensibilisation absolue des cellules à l'égard du venin."

Of great importance in their practical bearing are the experiments which are recorded on the *local* action of anti-abrine and anti-venomous serum respectively. As is well known, abrine was at one time used for the treatment of trachoma, but unfortunately the subsequent suppuration which attended its use was in many cases so intense and so dangerous that it had to be abandoned for therapeutic purposes.

Now Calmette has found that by applying anti-abrine serum to the local parts affected, the inflammatory action of abrine is modified in a very remarkable manner, and the hope is held out that by using this serum, and so controlling the inflammation induced by the application of abrine, this valuable substance may once more be reinstated in the therapeutics of ophthalmology. Anti-venomous serum has apparently the same local immunising action as the anti-abrine serum.

Another practical point of great importance concerning these serums is also dealt with in detail; this is the diagnostic value attaching to their use. Already Pfeiffer and other investigators have shown how, by means of serum, it is possible to differentiate between cholera and other non-pathogenic vibrios, and to distinguish the typhoid from the closely-allied *B. coli communis*. A most interesting opportunity occurred for testing the diagnostic power of anti-venomous and anti-abrine serums respectively. In India the natives frequently wreak their vengeance on their enemies by poisoning their domestic animals, and the substances selected for this purpose are those which they know will be with difficulty detected by expert analysis. Two materials are specially favoured by them for this purpose, *i.e.* abrine and serpent venom. One method of administering the poison consists in taking short pieces of wood shaped in the form of a club, in the thick end of which small-pointed rods are carefully fitted. These rods are composed of a hard greyish-looking substance. Armed with these tiny clubs, which they can easily conceal in their hands, they inflict small scratches, scarcely visible, upon the cattle, but in the production of which the pointed end of the little rod is broken off, and in this manner the cattle become inoculated with the poison. Some of these small broken-off points were sent by Mr Hankin, of Agra, to Dr. Calmette for examination. On dissolving these fragments in water and inoculating the liquid into rabbits, the latter died, exhibiting the symptoms typical of abrine poisoning. The same quantity of this liquid mixed with some anti-abrine serum produced no toxic result whatever. Thus Dr. Calmette considers his diagnosis of the poison employed as being abrine fully justified. In a somewhat similar manner the use of serpent venom was also detected.

These results open up a new avenue to the physiological detection of toxins, whether of animal, vegetable, or bacterial origin by means of serums.

Some extremely interesting experiments were also made to ascertain whether toxins and antitoxins were capable of modifying one another outside the body *in vitro*. The following examples give some idea of the results obtained. 5 cubic centimetres of anti-venomous serum were mixed *in vitro* with 4 milligrammes of cobra venom, and this mixture was injected intravenously into a rabbit. The animal remained unaffected; at the end of an hour, this same rabbit was again intravenously inoculated with 1 milligramme of venom. It died thirty-five minutes afterwards. Thus although its death was slightly deferred beyond that which was noted for the control animal, yet it succumbed almost as readily as if it had received no protective serum whatever. Again, 5 cubic centimetres of anti-venomous serum were mixed with 4 milligrammes of venom and 1 cubic centimetre of a 10 per cent. solution of hypochlorite of lime, and the whole was inoculated into a rabbit. This same animal, on subsequently receiving a dose of venom usually fatal, suffered no ill-effects at all. In this case, Dr. Calmette points out, that whilst the serum had remained unaffected by the addition of a chemical substance, the toxic nature of the venom had, on the contrary, been entirely destroyed. Hence it is claimed that when toxins and their anti-toxins are mixed *in vitro*, the former do not appear to undergo any change or modification through the presence of the latter. Therefore, either these substances can remain side by side outside the body intact, or, if any combination between them does occur under these circumstances, it is a combination which is so unstable that the application of heat or various chemical substances is able to easily bring about their disunion, restoring to either the properties they possessed before being brought into contact. Dr. Calmette, in concluding his most valuable memoir, records a large number of experiments made to ascertain what is the degree of protective power exercised by anti-toxic serums of different origin and certain liquids on animals inoculated with abrine. It has been found that broth freshly prepared, normal ox-serum, anti-tetanic serum, anti-diphtheritic serum, anti-anthrax serum, and, above all, anti-cholera serum, exert individually a decided immunising action with regard to abrine. Although the protective action of these so-called foreign serums is not so pronounced as in the case with anti-abrine serum, yet they do most undoubtedly confer a certain degree of protection. Dr. Calmette considers that this artificially induced immunity must be regarded as a condition in which the cells of the body are specially stimulated, and are thus enabled to either temporarily or permanently resist the action of particular poisons.

The mechanism of immunity will not permit itself to be lightly mastered, and it is only by the conduct of painstaking and patient inquiries, of which those just described are such a splendid example, that a comprehension of this most important as well as fascinating phenomenon can ever be hoped for.

ON THE VARIATION OF LATITUDE.[1]

AT the autumn meeting of the National Academy in 1894, which was the last occasion upon which the author asked for its attention to this subject, he presented the numerical theory of the motion of the pole, synthetically derived from the observations from the beginning of the history of the astronomy of precision up to that time, in its complete development, exactly as it stands to-day. Since then he has been interested to compare it with the various series of observations, as they have been published from time to time, not only for the purpose of verification or improvement of the numerical values of the various constants, but also to detect any additional characteristics which these later data might make apparent. These additional investigations have individually been neither extensive nor important enough to call for separate publication; since their general result has been merely a satisfactory confirmation of the

1 Abstract of a paper read before the National Academy of Sciences at Washington, April 21, by Prof. S. C. Chandler.

previous deductions as to the nature of the laws of these motions, without furnishing material improvement of the numerical elements. But sufficient material has thus been gradually accumulating to make the present communication of some interest.

The new material to be here utilised consists of the various series of observations by Tallcott's method up to the middle of 1896, as far as published, at the following European stations, named in the order of longitude: Kasan, Vienna, Prague, Berlin, Potsdam, Karlsruhe, and Strasburg. America has Doolittle's series at Bethlehem, which was brought to an end in the summer of 1895. He is now carrying forward a new series at Philadelphia, of which the results may soon be expected. Of the series at Columbia University, by Rees, Jacoby and Davis, begun in the spring of 1893 and still current, the results for the first fourteen months came into the author's hands a few days ago, so that he was able to incorporate them in his investigations.

The curves of latitude-variation from these various series were then exhibited, and comparisons made with the known numerical theory. This shows a concordance and fidelity of representation which is in every way satisfactory, the difference between computation and observation being practically within the range of the uncertainty of errors of observation.

A determination of the elements of the ellipse of the annual component of the polar motion was then presented, made from the new observations independently of the older ones previously used. The resulting elements are practically identical as to form, size, and position. This seems to show that the axis of this elongated vibratory motion is stationary on the earth's surface along a meridian forty-five degrees east of Greenwich. This negative evidence as to any apsidal motion seems to be of extreme importance in its bearing on the theory of the earth's rotation.

A demonstration was then presented of the fact that since 1890 the circular 428-day motion has been diminishing its radius, in conformity to the requirements of the numerical theory derived from the observations from 1825 to 1890.

In addition to the above, a discussion of 718 observations of the Pole-star, made with the Pulkova vertical circle between 1882 and 1891, was given. This series is especially interesting and important in that it covers an interval during which we have very little other information, of an extended character, as to the variations of latitude. A comparison of the curves of observation and theory, thus provided for this decade, exhibited the most startling accordance, and seems to leave no possible doubt that Nyren's inference, that his observations do not betray evidence of the existence of the annual component of the polar motion, is erroneous and attributable to illogical methods in drawing his conclusions.

TECHNICAL EDUCATION IN LONDON.

THE work of the Technical Education Board of the London County Council has been favourably commented upon in these columns on many occasions. The Board includes among its members several well-known educationists; and in its Secretary, Dr. W. Garnett, it possesses an official whose knowledge of science makes him capable of taking a wide view of things, and of seeing the best and most practicable lines of development of technical education. The fourth annual report of the Board, presented to the Council on Tuesday, is a substantial testimony of work accomplished during the year ending with March. To do the report justice would take many columns of NATURE, but brief references to a few of the operations of the Board will, perhaps, suffice to give an idea of the valuable and extensive character of the work carried on.

The Board has continued its policy of attempting primarily to coordinate and develop the provision for technical education made by the various public institutions of the metropolis. By its grants of money, no less than by the expert assistance which it has placed at the disposal of the various governing bodies, the technical work of these institutions has been greatly extended during the past year. There are now no fewer than ninety-eight separate institutions in London to a greater or less extent supported by the Board, and inspected by its officers.

Special attention has been paid to developing and improving the instruction provided for apprentices, improvers and journeymen in the principal London industries. There are now more than two hundred well-equipped and efficient centres of definitely practical instruction in various trades. The character of the instruction given differs slightly, but, on the whole, it is of a kind that will assist industrial progress. As to instruction in electrical engineering, it is a noteworthy fact that from sixteen to eighteen students from the Royal College of Science have been attending the evening classes for electrical engineers at the South-West London Polytechnic Institute. This may be taken as good evidence of the Polytechnic's efficiency.

London now has eleven polytechnic institutions, which have on their rolls probably not fewer than 40,000 separate members or students. Nearly all the polytechnics provide instruction in science, art, technology, commercial subjects, literary subjects and domestic economy, and during the session 1895-96, before the Northampton Institute and the Northern Polytechnic were opened, the students registered at the London polytechnics, including the People's Palace and the Goldsmiths' Institute, in the several departments, were—

Science	8371
Art	2910
Technology	4692
Domestic economy	2678
Commercial subjects	8244
Total	26,895

The eleven polytechnic institutes referred to may be estimated for the current session 1896-97 to be spending in all their departments a total of about 128,000*l.* per annum, of which, roughly speaking, 29,000*l.* will probably be provided by the City Parochial Trustees, 25,000*l.* by the Technical Education Board, 22,000*l.* from City Companies, 12,000*l.* from private subscriptions and other endowments, 9000*l.* from Government grants, and 30,000*l.* from students' fees, &c. The total capital expenditure can only be roughly guessed at, but it will certainly have exceeded 500,000*l.* They may be expected to have in 1897-98, a total of about 45,000 separate students in all subjects, as compared with a corresponding total for 1892-93 of probably not more than 20,000.

The development of the higher departments at several of the polytechnics has during the last two or three years greatly increased the provision of higher instruction, especially in engineering, chemistry and physics. In the new and well-equipped laboratories now provided at these institutions by means of the Board's equipment grants, facilities are given for the student to pursue his work, without a break, from the elements of the subject up to the highest branches, and to undertake, in conjunction with his teacher, original investigation and research. A considerable addition has thus been made to the instruction of distinctly university rank now accessible to the London student, and it is estimated that, in addition to a large number preparing for matriculation, there are now over one hundred matriculated students in the polytechnics who are definitely studying for London university degrees in science. This number constitutes no small proportion of the total of matriculated students for science degrees, other than those in the medical schools, who are studying in organised educational institutes in London.

This great development of instruction of university rank in new institutions has increased the importance of bringing about a more systematic coordination of university education in London. The Board has accordingly continued to press for the early establishment of the promised new Teaching University for London, towards the technical departments of which it was proposed in Mr. Llewellyn Smith's report that the Board should contribute. The establishment of a well-endowed Teaching University for London, which should effectively coordinate and direct all the teaching of university rank that is now scattered about the metropolis, would probably do more than anything else to promote technical education. When this university will be established, it would be unwise to guess. Meanwhile the Board has attempted to bring about more coordination between the different institutions providing university instruction in technical subjects, and arrangements are in progress for courses of inter-collegiate lectures, mainly in post-graduate and specialist subjects, which will be open to all students of the various institutions concerned.

An interesting map, showing the places of residence of the thousand junior county scholars elected by the first four competitions of the Board, in the years 1893-95, accompanies the report. The map shows that the scholars were distributed with fair uniformity about the whole area of the county of London.

THE MANUFACTURE OF CARBORUNDUM AT NIAGARA FALLS.[1]

THE first carborundum furnace consisted of an iron bowl lined with carbon, and a carbon rod; a mixture of clay and carbon was introduced into the bowl, and the rod placed in the mixture. A current sufficient to fuse the mixture, or at least to bring it to a very high temperature, was now passed through the furnace, the iron bowl and carbon rod serving as terminals or electrodes. When the current was cut off, and the furnace had cooled down, it was opened, with the result that a few bright blue crystals were found surrounding the carbon rod.

The furnaces constructed after this first experiment approached more nearly in form the furnaces in use to-day. They were built of brick, their internal dimensions being 10 inches in length, 4 inches in width, and 4 inches in depth. The terminals were a pair of carbons, which could be moved longitudinally, thus permitting the distance between them to be altered at pleasure. These were essentially arc furnaces; that is to say, the idea was to form an arc between the terminals, and to bring about the necessary chemical changes by the high temperature thus produced. It was soon found, however, that this method of working was not satisfactory, and the incandescent furnace, which is the kind that is now adopted, was therefore constructed.

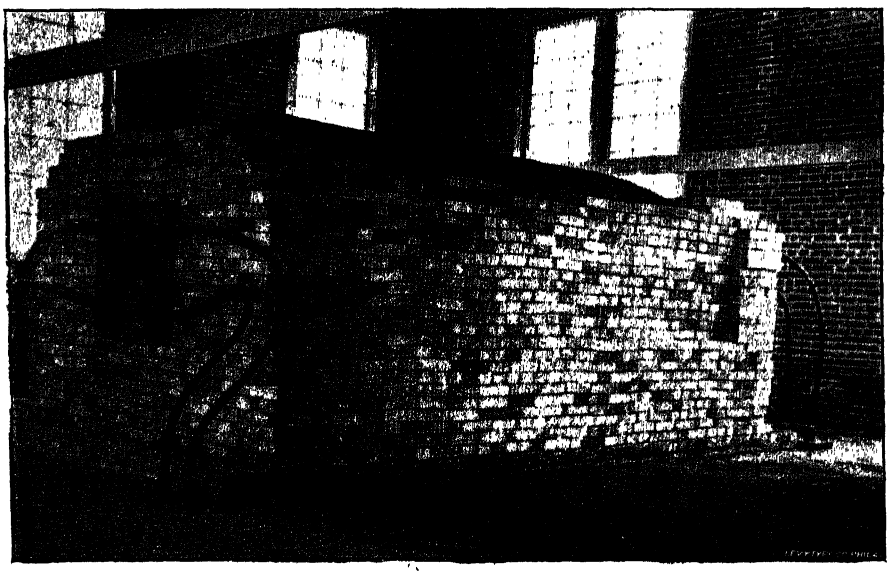


FIG. 1.—Carborundum furnace ready for operation.

Into furnaces of this kind a core consisting of granulated coke, which forms a continuous electrical connection between the carbon terminals, is introduced. By adjusting the diameter of the core to the proper size, it is heated to a sufficiently high temperature, by the passage of the current, to convert the surrounding mixture into carborundum.

It was at first supposed that the crystals formed in the furnaces were a compound of aluminium and carbon, but it was soon found that the amount and quality of the carborundum depended on the amount of silica present in the mixture. A good glass sand was, therefore, substituted for the clay in the mixture. It was also found that the addition of a little salt to the mixture facilitated the running of the furnaces. Some trouble was experienced from the gases formed during the running of a furnace, and to lessen this, sawdust was added to the mixture to render it porous, and to allow the free escape of the gas. The output of these small furnaces amounted to about a quarter of a pound a day.

The crude materials for the manufacture of carborundum at Niagara Falls are sand, coke, sawdust, and salt. These are ready for immediate use, with the exception of the coke, which must be reduced to kernels of a certain size, to be used as "core," and ground to a fine powder, to be used in making the mixture or charge for the furnaces. The furnaces are built of brick, and have the form of an oblong box, the internal dimensions being, approximately, 16 feet in length, 5 feet in width, and 5 feet in depth (Fig. 1). The ends are built up very solidly, with a thickness of about 2 feet. In the centre of either end are the terminals, consisting of sixty carbon rods 30 inches long and 3 inches in diameter. The outer ends of the carbons are enclosed in a square iron frame, to which is screwed a stout plate, bored with sixty holes corresponding to the ends of the carbons. Through each of these holes is passed a short piece of ⅜-inch copper rod, fitting tightly in a hole drilled in the carbon. Finally, all the free space between the inside of the plate and the ends of the carbons is tightly packed with graphite. Each plate is provided with four projections, to which the cables conveying the current may be bolted. These ends are the only permanent parts of the furnace; the remainder is built up every time the furnace is operated.

The side walls of the furnace are first built up to a height of about 4 feet. Pieces of sheet iron are then placed at a distance of about 4 inches from the inner ends of the carbon terminals in such a way as to keep the mixture from coming in contact with the latter. The mixture is then thrown into the furnace until it is rather more than half full. A semicircular trench, having a radius of 10½ inches, and extending from end to end of the furnace, is now formed, the bottom of the trench being a little above the level of the bottom row of carbons. Into this trench is introduced the core, which has been carefully weighed, so that the amount required to make the core of the right size is used. All the core having been emptied into the trench, the top is rounded off neatly by hand, so that, when finished, we have a solid cylinder 21 inches in diameter and about 14 feet long, composed of small pieces of coke, and extending from the sheet iron plates at either end of the furnace.

The next operation is to make the connections between the core and the terminals. This is done by packing finely-ground coke into the spaces between the ends of the carbons and the pieces of sheet iron, after which the walls are built up to a height of about 5 feet, the pieces of sheet iron removed, and more mixture thrown in and heaped up to a height of about 8 feet.

All that is required now to make carborundum is the electric current. The current as supplied from the Niagara Falls Power Company has an electromotive force or pressure of 2200 volts, so that in order to use it in the furnaces it must be transformed to a lower voltage. The transformer at the Carborundum Works has a maximum capacity of 830 kilowatts, or about 1100 horse-power, and transforms the 2200-volt current into one of only 185 volts. Associated with the transformer is a regulator, by means of which the current from the former can be raised to 250, or lowered to 100 volts.

After the circuit has been closed in the transformer-room, no apparent change occurs in the furnace for about half an hour. Then a peculiar odour is perceived, due to escaping gases, and when a lighted match is held near the furnace walls the gas ignites with a slight explosion. When the current has been on for three or four hours, the side walls and top of the furnace are completely enveloped by the lambent blue flame of carbon monoxide gas, formed by the combination of the carbon of the coke with the oxygen of the sand. During the run of a single furnace 5½ tons of this gas are given off. At the end of four or five hours the top of the furnace begins to subside gradually,

[1] Abridged from a paper by Mr. Francis A. Fitzgerald, in the *Journal* of the Franklin Institute, February 1897.

fissures form along the surface, from which pour out the yellow vapours of sodium. Occasionally, the mixture on the top of the furnace is not sufficiently porous to allow the rapid escape of the gases. The result is, that the latter accumulate until the pressure is so great that, at some weak point in the mixture above, a path is forced open and the gases rush out violently. It is mainly for the purpose of avoiding this "blowing" that the sawdust is put in the mixture, since the former, by making the mixture porous, allows the gases to escape freely.

At the end of about twenty-four hours the current is cut off from the furnace, and it is allowed to cool for a few hours. Then the side walls are taken down and the unchanged mixture raked off the top of the furnace, until the outer crust of amorphous carborundum is reached. This crust is cut through with large steel bars, and can then be easily removed from the inner crust of amorphous carborundum. The inner crust is next removed with a spade, and the crystalline carborundum exposed.

A cross-section of a carborundum furnace presents an interesting and beautiful appearance (Fig 2). In the centre is the core, which, on examination, is found to be very different in some of its physical characteristics from the coke of which it was originally composed. It no longer possesses a bright metallic appearance. Many of the kernels are quite soft, and can be squeezed between the fingers, leaving on them a mark like black lead. In fact, the high temperature to which the core has been raised has driven off all impurities from the coke, leaving nothing but pure carbon, either in the amorphous or graphitic form. From the core radiate beautifully-coloured carborundum crystals to a distance of 10 or 12 inches. A single furnace yields over 4000 pounds of crystalline carborundum. Most of these crystals are not remarkable as regards their size, but in places where hollows have formed, large hexagonal crystals are found, sometimes measuring ½ inch on a side. At the distance of 10 or 12 inches from the core the crystals suddenly cease, and, instead, we find a thin layer of a light-green colour, which is the inner crust of amorphous carborundum. Beyond this is the outer crust of amorphous carborundum, and this also ends abruptly in unchanged mixture. Other curious substances are sometimes produced in the furnaces; for example, silica, which has the appearance of spun glass. On opening a furnace and cutting down to the core, a layer is found that appears at first sight to consist of very dull black carborundum crystals. On closer examination, however, it is found that though this material has the exact form of the carborundum crystals, it is nothing but pure carbon in the graphitic form.

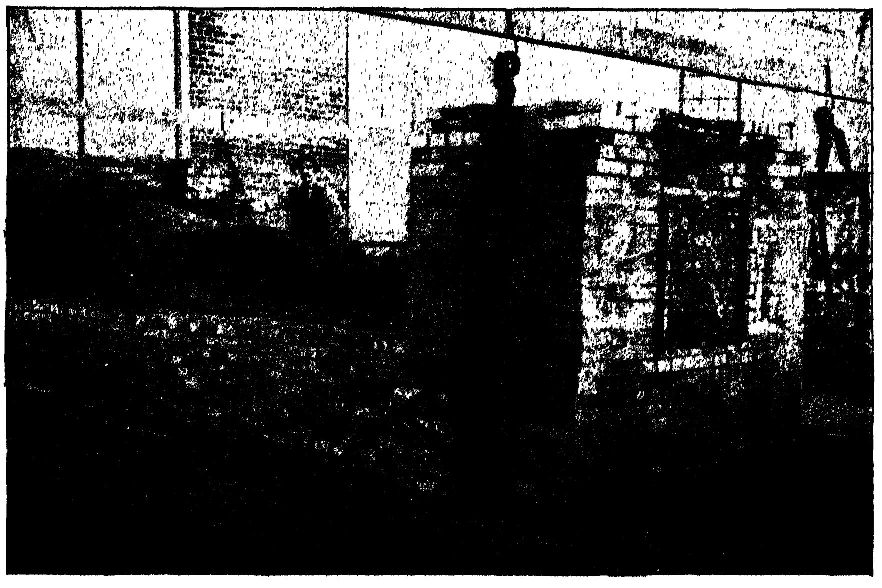


FIG. 2.—Furnace opened to show formation of carborundum around the core.

After the carborundum has been removed from the furnace it is taken to a crusher, which consists of a large iron pan, rotated in a horizontal plane by means of a vertical shaft. A horizontal shaft, carrying two heavy rollers, is attached to a collar surrounding the vertical shaft, thus permitting a free vertical motion of the rollers which rest in the pan. The latter, in revolving, causes the carborundum to pass under the rolls, which break the mass of crystals apart. From the crusher the carborundum is taken to large wooden tanks, where it is treated for several days with dilute sulphuric acid to remove impurities. It is then thoroughly washed, dried, and graded.

Carborundum is apparently infusible; for after a certain temperature has been reached, decomposition commences, without fusion, and the crystals are broken up into carbon and silicon. It is quite insoluble in water or any acid. Its hardness lies somewhere between 9° and 10°, probably very close to 10°, which is the hardness of diamond. An attempt was made to obtain some idea of the relative hardness of diamond, corundum, and carborundum, by the following experiment.

A series of lines was scratched on a small plate of glass with each of the three materials, and the scratches examined with a microscope. The appearance of the lines made by the diamond and the carborundum crystal was indistinguishable; but that made with the piece of corundum was quite different, being rough, and not presenting the clean-cut outlines of the other scratches. This seems to show that carborundum is much nearer diamond than corundum in hardness, although it is not as tough. The specific gravity of carborundum is 3·23, which is less than that of emery, 1¼ pounds of the latter being equal in volume to 1 pound of the former.

Carborundrum is chiefly used at present as an abrasive, for which purpose it possesses many advantages over emery and corundum. The Carborundum Company produced during the year 1896, in round numbers, 1,191,000 pounds of crystalline carborundum.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof E. B. Elliott and Prof. H. H. Turner have been appointed Electors to the Savilian Professorship of Geometry.

The Board of the Faculty of Natural Science have given notice that henceforth in the Final Honour School of Chemistry the use of books in the examination in Quantitative Analysis, and in any part of the examination, shall be at the discretion of the Examiners.

Trinity College has decided to build a laboratory adjoining the existing laboratory of Balliol College, and communicating with it. Such action in favour of Oxford science on the part of a College, far from rich, is especially commendable.

This term Mr. H. H. Champion, of Cambridge, is lecturing, for Prof. Turner, on "Lunar Theory." Prof. Ray Lankester will lecture on Arthropoda, and Mr. G. C. Bourne on Mechanical Theories of Development. Dr. Benham and Mr. Bourne are conducting the annual summer course of Practical Embryology.

Prof. E. B. Tylor's subject for this term is the Anthropology of Political and Social Institutions. Mr. Barclay Thompson

announces courses on Mammalian Morphology and Palæontology. The usual courses are being given in the departments of Physics, Chemistry, Mineralogy and Botany and Physiology.

In the Faculty of Medicine, Dr. Ritchie, Lecturer on Pathology, will give a course of practical instruction on Bacteriology. Lectures will also be given on Medicine, Surgery, and Materia Medica. Prof. Arthur Thomson is lecturing on the Uro-genital system.

April 13 being the twenty-fifth anniversary of the Zoological Station at Naples, Dr. Anton Dohrn sent a telegraphic message to the Chancellor, acknowledging the assistance rendered by the University to the Station.

Prof. Burdon Sanderson has been re-elected Chairman of the Board of Faculty of Medicine.

The large and valuable collection of butterflies offered to the Hope Department of the University by Mr. F. Ducane Godman, F.R.S., and Mr. Osbert Salvin, F.R.S., was accepted by Convocation on Tuesday, and the thanks of the University were voted to the donors. The collection has already been briefly described in NATURE (vol. lv. p. 524, April 1).

CAMBRIDGE.—A memorial, signed by 2100 resident undergraduates and bachelors of arts, has been presented to the Vice-Chancellor, protesting against the proposal to grant titles of degrees to women, on the ground that this would injure the position and efficiency of the University as a University for men. A counter memorial, signed by only 298 of the junior members of the University, has also been received. It states that in the opinion of the signatories the proposal would *not* injure the University. Meanwhile the notice of *non-placet* by the resident graduates has been circulated, and bears the names of about 280 members of the Senate, out of about 450 in actual residence. The list includes eighteen professors and 110 past or present tutors and lecturers. If, therefore, the decision lay with the resident body of teachers and officers, the result would be a decided negative; and there is no doubt that among the students the feeling against the contemplated change is overwhelmingly strong. The latter fact gives some colour to the assertion that the admission of women would probably be followed by a serious falling off in the number of men desirous of entering the University.

The proposal of the Special Board for Physics and Chemistry, that candidates for either part of the Natural Sciences Tripos should be required to submit to the Examiners their laboratory note-books, duly attested by the signatures of their teachers, has been adversely criticised in the Senate. It was feared that it might interfere with the good relations at present existing between teachers and students, and encourage the special preparation of note-books for the Examiners' inspection. The Report was referred back to the Board for reconsideration.

The dates of the next ensuing College Examinations for Scholarships and Exhibitions in Natural Science are announced as follows:—November 2: St. John's and Trinity, Pembroke, Caius, King's, Jesus, Christ's, and Emmanuel. November 30: Peterhouse and Sidney Sussex. December 7: Clare and Trinity Hall. April 1898: Downing. Information as to the value and conditions of tenure of the several emoluments may be obtained from the respective College Tutors.

WE understand that the late Prof. Edward D. Cope left an estate valued at over one hundred thousand dollars. Most of the amount is bequeathed to the University of Pennsylvania, and to establish a chair of Vertebrate Palæontology in the Philadelphia Academy of Natural History.

AMONG the grants just authorised by the legislature of the State of New York are: 2,500,000 dols. for the new public library in New York City; 500,000 dols. for an extension of the Museum of Natural History; 150,000 dols. for the new Zoological Park in New York City; and 10,000 dols. for the proposed public library in Brooklyn.

In a brief note (p. 21) on the application of the Hartley Institution for a share of the increased grant which it is proposed to give to the University Colleges of Great Britain, the term "professorial" staff was misprinted "professional" staff. Dr. R. W. Stewart, the Principal of the Institution, calls our attention to the fact that the Committee appointed to consider the distribution of the Government grant gave, in 1889, what almost amounted to a pledge that if certain defects in the Institution were remedied, a future application for a share of the grant might receive favourable consideration. The work and management of the Institution have since then been entirely reorganised, and it is on these grounds that the application has been renewed.

THE following are among recent appointments:—Dr. C. H. Draper to be head-master of the Municipal Technical School at Brighton; Miss M. Maclean to be demonstrator of anatomy, and Miss D. Clark demonstrator in the botanical laboratory, in Queen Margaret College, Glasgow; Mr. W. H. Lang to be lecturer on botany in the same college; Dr. Frech to be professor of geology and palæontology at Breslau; Dr. Walter Kruse to be professor of hygiene at Bonn; Dr. W. Ule to be professor of geography at Halle; Dr. Gustav Jäger, privat-docent in theoretical physics at Vienna, to be a professor; Prof. W. F. Edwards to be president of the Washington University, Seattle; Dr. Andr. Lipp to be professor of analytical chemistry in the Polytechnic Institute at Munich. Prof. Sissingle, of the Polytechnic Institute of Delft, has been called to the chair of Physics in the University of Amsterdam.

THE Technical Education Board of the London County Council will proceed shortly to award not less than five Senior County Scholarships, which are of the value of 60*l*. a year, together with payment of tuition fees up to 30*l*. a year, and are tenable for three years at university colleges and advanced technical institutes. These scholarships are confined to residents within the administrative county of London, and are only open to those whose parents are in receipt of not more than 400*l*. a year. Candidates should, as a rule, be under twenty-two years of age, though the Board reserves the right to give preference to candidates who are under nineteen years of age. The scholarships are intended to encourage more especially the teaching of science, and to enable those students who cannot afford a university training to pursue advanced studies for a period of three years in the highest university institutions in the country. Candidates must apply before Monday, May 17, to the Secretary of the Technical Education Board, St. Martin's Place, W.C.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xix. No. 2 (April 1897).—On the most perfect forms of magic squares, with methods for their production, is an interesting paper on these squares by Dr. E. McClintock, which treats the subject in a somewhat novel manner. As it was read before the American Mathematical Society so long ago as April 25, 1896, the references to the Rev. A. H. Frost's work on similar lines make no allusion to the recent memoir by this gentleman (the construction of Nasik squares of any order), which was read before the London Mathematical Society, June 11, 1896, and, in its printed form, occupied pp. 487–518 of vol. xxvii. of the Society's *Proceedings*. Dr. McClintock refers to the earlier papers in the *Quarterly Journal of Mathematics* (vol. vii. and xv.).—Dr. Chree contributes a complementary paper to his article in vol. xvi. Its title is "Isotropic elastic solids of nearly spherical form." The method of the two papers is practically the same, but the author states the differences in detail to be considerable. His principal object is to find what may be regarded as the change in pitch due to a small change in the shape of the surface; the result shows what effect an absence of perfect sphericity has on the frequency of vibrations.—Non-uniform convergence and the integration of series, term by term, by W. F. Osgood, is a paper which was read at the August (1896) meeting of the American Mathematical Society. The geometrical method for the study of uniform convergence, set forth in the present article, was treated at some length in a paper by the same writer, which we have noted in our abstract of the Society's *Bulletin* (vol. iii. pp. 59–86) for November 1896.—Two notelets close the number: viz. a note on the factors of composition of a group, by Ellery W. Davis, and simple proof of a fundamental theorem in the theory of functions, by R. D. Bohannan.—A loose sheet gives a very brief outline of Sylvester's career and work. Prof. Sylvester was the principal founder of the *American Journal of Mathematics* (in 1877), and he was the principal editor until his departure from America in December 1883. He contributed to its pages some fifty papers in all.

Bulletin of the American Mathematical Society, vol. iii. No. 7 (April 1897).—On Cayley's theory of the absolute, is a paper by Prof. C. A. Scott, which was read at the January (1897)

meeting of the Society. Miss Scott attempts to show, "as a matter of purely pedagogic interest," how simply and naturally Cayley's theory follows from a small number of very elementary geometrical conceptions, without any appeal to analytical geometry. Lines common to four linear complexes, is a short note, by Dr. V. Snyder, which was read at the February meeting.—The cubic resolvent of a binary quartic derived by invariant definition and process, by Prof. H. S. White, was read at the Chicago Conference (January 1, 1897).—Dr. Isabel Maddison reviews two recent works on geometry, viz. Phillip's and Fisher's "Elements of Geometry," and H. D. Thompson's "Elementary Solid Geometry and Mensuration," which she thinks rise above the general level. Dr. Maddison also points out that the map-colouring problem was discussed (before Cayley and De Morgan wrote upon it) by Möbius, in his lectures in 1840. The problem was propounded to Möbius by Prof. Weiske, and is to be found in the *Berichte der Sächsischen Gesellschaft der Wissenschaften zu Leipzig*, Math.-physiche Classe, Bd. 37, 1885. The Note referred to is by Prof. Baltzer, and its title is "Eine Erinnerung an Möbius und seinen freund Weiske."—The Notes contain the mathematical courses at the Universities of Berlin and Harvard.

THE last number of the *Journal of the Russian Chemical and Physical Society* contains, in an appendix, the third instalment of the "Record" (*Vremennik*) of the Russian Chief Board of Measures and Weights. Most of it is given to an elaborate paper, by Prof. Mendeléeff, on the "Methods of Accurate or Metrological Weighings." The formulæ relative to the oscillations of the scales' index, and to the "condition" of the scales, are discussed in great detail, and new formulæ are given; while the discussion of some of the results has brought the Russian professor to the discovery of a new property of the parabola relative to the surface of a segment of it (*Comptes rendus*, 1895, p. 1467).—The same issue contains papers on the quantity of carbon dioxide contained in the air of the Weighing Hall of the Board of Measures and Weights, by A. Dobrokhotoff; the results of the verification at the Standards Department of the Board of Trade, in 1894 and 1895, of the Avoirdupois Pound belonging to the Russian Government, and the comparison of the Russian half-sashen with the Imperial standard yard, by H. J. Chaney, Mendeléeff, and Blumbach (in English and Russian); on the geographical position of the Board of Measures (chiefly its exact altitude above the sea-level); and a note, by Prof. Mendeléeff, on the agreement of the author's well-known formula for the density of water at different temperatures with the last measurements of the same, by M. Thiesen.

Bollettino della Società Sismologica Italiana, vol. ii., 1896, N.N. 7, 8.—Influence of the different nature and sensitiveness of instruments on the measure of the velocity of seismic waves, by G. Agamennone.—On the geodynamic system of the world, by G. Grablovitz.—Summary of the principal eruptive phenomena in Sicily and the adjacent islands during the six months July–December 1896, by S. Arcidiacono.—Velocity of propagation of the earthquake of Ahmed (Asia Minor) of April 16, 1896 (in French), by G. Agamennone.—Vesuvian notes for the year 1896, by G. Mercalli.—Notices of earthquakes recorded in Italy, August 31–September 8, 1896; the most important being a series of records of the Iceland earthquake of September 6.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 8.—"Further Note on the Sensory Nerves of Muscles." By C. S. Sherrington, M.A., M.D., F.R.S., Holt Professor of Physiology in University College, Liverpool. Received February 26.

I was somewhat surprised when, after the sensory nature of the structures originally termed muscle-spindles (Kühne) had been proved (Sherrington), I was unable to find in the eye-muscles any examples of these structures. I had expected to find in those muscles, on account of the great delicacy of their control and coordination, and in view of the well-known richness of their innervation, a field peculiarly favourable for the examination and study of "spindles."

I had noted that the intrafusal muscle-fibres, of the "red" variety as they are, undergo, when the nerve-trunk of a muscle has been severed, a much slower course of alteration than do extra-fusal muscle fibres, *i.e.* I found no pronounced degeneration for even two years following section. I therefore cut through *n. oculomotorius* at its origin, and examined the resultant degenerations in the eye-muscles which it innervates and in their individual nerve-trunks.

In the nerve-trunks, extra-muscular and intra-muscular, the Wallerian degeneration clearly demonstrated that, with the exception of a few minute fibres, of variable number, derived perhaps from the ciliary ganglion, *all* myelinate nerve-fibres in all these eye-muscles degenerate. Therefore these eye-muscles derive the vast majority of their myelinate nerve-fibres from *n. oculomotorius*. The sensory innervation of these muscles is not, therefore, derivable from the fifth cranial pair. In accord with this, I found (α) that severance of both trigemini caused no obvious impairment of the movement of the eye-balls, (β) that the combined severance of both *nn. trigemini*, and of both optic nerves, even after section of the encephalic bulb, did not severely depress the tonus of the eye-muscles. Now we know that section of the sensory spinal roots belonging to muscles does very severely depress the tonus of them.

At the same time, I was struck with the long distance to which many of the nerve-fibres in these muscles travel forward towards the ocular tendons of the muscles. I was the more impressed with this fact because direct examination proved that the regions of the distribution of motor end-plates in these muscles is almost confined to the middle portion of the fleshy mass of the muscle. Further investigation of the course and destination of the nerve-fibres at the tendon end of the muscle revealed them (both in cat and monkey) undergoing terminal subdivision, and in numerous instances passing beyond into the bundles of the tendon itself. The terminations of some of these nerve-fibres lie within the tendons; many recurve again towards the muscular fibres, and end just at junction of muscle-fibre with tendon-bundle. The nerve-fibres in so terminating frequently become thick—as I have described in the case of muscle-spindles—with shortened internodes.

My observations have included also the fourth cranial pair, and with like result. Investigation of the sixth cranial pair is also in progress.

It also appears from the above that the absence of the distinct Kühne-Ruffini "spindles" from a muscle does not exclude the possession by it of sensorial end-organs, and of afferent nerve-fibres. This point is not without importance, because examination of various muscles has led me to the conclusion that the "spindle-organs" are absent from the following muscles:—From all the orbital eye-muscles; from the intrinsic muscles of the larynx, though Pacinian corpuscles occur, as in various other muscles; from the intrinsic muscles of the tongue, and from the diaphragm. It is notable that all these muscles belong to that set which are innervated by nerve-fibres of rather smaller calibre (Gaskell) than those supplying the skeletal muscles generally; that is to say, are innervated by the non-ganglionated splanchnic efferent nerves of Gaskell.

"On Boomerangs." By G. T. Walker, M.A., B.Sc., Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S. Received March 15.

A typical returning boomerang resembles in general outline a symmetrical arc of a hyperbola, and is about 80 cm. in length measured along the curve. At the centre, where the dimensions of the cross section are greatest, the width is about 7 cm., and the thickness 1 cm.

Of the two faces, one is distinctly more rounded than the other; in addition the arms are twisted through about 4°, in the same manner as the blades of a right-handed screw propeller.

Such an implement, if thrown with its plane vertical, will describe a circular path of 40 or 50 metres in diameter, rising to a height of from 7 to 12 metres, and falling to the ground with its plane of rotation horizontal at a point somewhere near the thrower's feet.

The flight may be regarded as a case of steady motion, of which the circumstances gradually vary. In the more complicated, as well as the simpler, paths, observation makes it clear that everything depends on the changes in direction and inclination of the plane of the boomerang, and that the character of these changes is always the same; if they can be explained theoretically, the peculiarities of the motion may be accounted for.

Since the effects of the different forces at work are conflicting, it is necessary to adopt quantitative methods, even if the degree of accuracy attainable is not high; accordingly ratios

comparable with a tenth are treated as small, and their squares neglected.

If we regard the boomerang as a thin, slightly distorted lamina, and integrate over it the forces indicated in S. P. Langley's paper on "Experiments in Aerodynamics" ("Smithsonian Contributions to Knowledge," 1891), we can obtain equations of motion. From these, treating the motion as steady (to the first approximation), we may deduce the values of the angular velocities on which the direction of the axis of rotation depends. Five cases are worked out numerically, and the various effects of the "rounding" and "twisting" agree in character with the experimental facts; the discrepancies in actual magnitude are not larger than might, from the nature of the case, have been anticipated.

The theoretical results may be further tested by applying them to determine the conditions favourable to the production of other flights in which, after the first circle, a loop is described, either in front of or behind the thrower; in each of these cases success has been attained. An explanation is also afforded of the returning of a boomerang without "twist," made by Mr. O. Eckenstein, and of the wonderfully long, straight trajectories of some of the native non-returning implements.

Geological Society, April 28.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President, referring to the exhibit of models of the dorsal and ventral aspect of *Triarthrus*, said that these had been prepared and sent to him by Mr. Charles E. Beecher, of Yale University Museum. He was sure that they would prove of great interest to the Fellows, who were well acquainted with the extremely careful work which Mr. Beecher had done in connection with *Triarthrus*.—The following communications were read:—Note on a portion of the Nubian Desert south-east of Korosko, by Captain H. G. Lyons, R.E., with notes on the petrology by Miss C. A. Raisin, and water-analyses by Miss E. Aston. A general description of the physical structure of the area, which consists mainly of Nubian sandstone and crystalline rocks, was given. Coming from Korosko to the Murrat Wells, the crystalline rocks are first met with on the east side of Jebel Raft. At Wadi dur Nabadi are ancient gold-workings. The crystalline rocks are both massive and schistose. On the crystalline mass of Jebel Raft, and apparently overlain by the Nubian sandstone, is a very coarse conglomerate containing fragments of crystalline rock, which appears to be older than the Nubian sandstone. The Nubian sandstone has little or no dip, and shows very slight variation in composition. The water-supply of the Nubian Desert is directly dependent on the rainfall, which is very irregular. The wells are sunk in the detritus of the valleys, and contain a large amount of mineral matter in solution, which renders them almost undrinkable; while the second source of supply—the rain-water reservoirs—are deep holes in the ravines which intersect the crystalline hills. These holes are attributed to water-action; and in the reservoir of Medina in Jebel Raft the spherical stones which assisted in forming the pothole still occur. The author believed that these ravines and reservoirs were formed at an earlier period than the present, when the rainfall was heavier. Miss Raisin gave accounts of both massive and schistose crystalline rocks, and also of sedimentary rocks. The crystalline rocks described include gneiss, hornblendite, gabbro, often much altered and resembling some of the Alpine gabbros, some allied rocks containing lustre-mottled hornblende, other forms of diabase, quartz-diorite, granite, felsites, certain schistose and a few distinctly fragmental rocks. None of the igneous rocks could be stated with certainty to have originated as a lava-flow. Many of them had undergone much alteration since their consolidation, and the results of this were described. There was clear evidence in many cases of erosion by desert-sand and the formation of a weathered coating. The schistose rocks did not present a very modern facies, and might be late Archæan or early Palæozoic. The massive crystallines may belong to different epochs, but include some rocks (such as the gneiss) resembling Archæan. These seemed to mark an eastward extension of the anticlinal axis previously traced by Captain Lyons to Wady Halfa in the Nile Valley from the west. Miss Aston gave two tables, one of which showed the actual amounts of substances found in the wells of Murrat, Bir Tilat Abda, and Bir Ab Anaga, while the second showed their approximate constitution.—On the origin of some of the gneisses of Anglesey, by Dr. Charles Callaway. The author still maintained the occurrence of two pre-Cambrian groups in Anglesey, the later of Pebidian age. In his paper a description was given of the production of gneissic structure in rocks of the earlier group occurring in the south of the island. The products of metamorphism were similar to those described by the author in the Malvern area. (1) Simple schists, granite is converted into mica-gneiss, diorite into hornblendic or chloritic gneiss, and felsite into mica-schist; (2) Injection-schists.

Zoological Society, May 4.—Mr. Herbert Druce, in the chair.—Mr. Oldfield Thomas exhibited a selection of the Mammals recently collected by Mr. A. Whyte during his expedition to the Nyika plateau and the Masuku mountains, North Nyasa. Mr. Thomas described as new a squirrel (*Xerus lucifer*), brilliant rufous throughout, with a black dorsal patch; a reed-rat (*Thryonomys sclateri*), allied to *T. gregorianus*, but with a longer tail, whitish instead of yellowish underside, and narrower and differently shaped skull; a mole-rat (*Georychus whytei*), like *G. nimrodi*, but with longer and broader frontal premaxillary processes; a pouched mouse (*Saccostomus elegans*), of a general buff colour and with a longer head than *S. campestris*; and *Mus nyikæ*, a rat of the size of *Mus chrysophilus*, but darker in colour and with a more rounded skull. A new subgeneric term (*Gerbilliscus*) was suggested for *Gerbillus boehmi*, Noack, of which Mr. Whyte had sent home specimens. Mr. Thomas also stated that the peculiar bulbous-tipped tail hairs described in *Petrodromus* proved to be confined to and characteristic of East African examples of the genus, which might therefore be specifically separated from the Zambezi forms as *P. sultani*.—Mr. Howard Saunders exhibited, on behalf of Mr. Henry Evans, a series of instantaneous photographs of the great grey seal (*Halichærus gryphus*) which had been taken in the Outer Hebrides.—Mr. J. E. S. Moore gave a general account, illustrated with the optical lantern, of the zoological results of his expedition to Lake Tanganyika in 1895 and 1896. Mr. Moore stated that the main object of the expedition had been to obtain materials for the morphological study of certain hitherto uninvestigated animal forms. It appeared that a key to the general interpretation of the lake-faunas of Central Africa would be most readily obtained by a study of their Molluscan Types. These showed that the faunas of most of the vast inland reservoirs of Africa were composed of normal lacustrine stocks, but that in Lake Tanganyika there were strange forms which certainly could not be included among such groups. All these forms appeared to have marine affinities; but, as they could not be directly associated with any living oceanic species, it was argued that they were probably the survivors of the marine fauna of some more ancient times, when Tanganyika was connected with the ocean. This theory was supported by the similarity of certain Tanganyika gastropods to ancient fossil shells.—A communication was read from Mr. Walter E. Collinge, on some European slugs of the genus *Arion*.—Mr. Sclater read a communication from Mr. Frederick J. Jackson, containing field-notes on the antelopes of Mau District, British East Africa.—The Rev. H. S. Gorham contributed a paper on the Coleoptera of the family *Endomychidæ* of the Eastern Hemisphere. Eighteen species were described, of which eleven were characterised as new.—Mr. F. E. Beddard, F.R.S., read a note upon the presence of intercentra in the vertebral column of birds. The existence of free intercentra in the caudal region was described in a number of genera belonging to many families of birds.

MANCHESTER.

Literary and Philosophical Society, April 27.—Dr. E. Schunck, F.R.S., President, in the chair.—Sir Henry E. Roscoe, F.R.S., was elected an honorary member. The following were elected officers and members of the Council for the ensuing year:—President, J. Cosmo Melvill; Vice-Presidents, Prof. O. Reynolds, F.R.S., Prof. A. Schuster, F.R.S., Charles Bailey, and W. H Johnson; Secretaries, R. F. Gwyther and Francis Jones; Treasurer, J. J. Ashworth; Librarian, W. E. Hoyle; other members of the Council, Prof. H. B. Dixon, F.R.S., Prof. H. Lamb, F.R.S., Dr. A. Hodgkinson, Francis Nicholson, J. E. King, and R. L. Taylor.—On the composition of some ancient Egyptian bronze and iron implements, by Dr. A. Harden. The author communicated the results of the analysis of two ancient iron chisels found in Thebes, and dating from about 600 B.C. Both of the implements contain a very small amount of carbon, and could not be rendered very hard by tempering. A specimen of bronze, dating from about 1500 B.C., was found to resemble modern bronze in its composition, consisting of copper alloyed with tin.

PARIS.

Academy of Sciences, May 3.—M. A. Chatin in the chair.—New classification of the Phanerogams, based upon the ovule and the seed, by M. Ph. van Tieghem. A summary of the preceding papers on this subject.—Researches on the composition of wheat, and on its analysis, by M. Aimé Gerard. During the process of milling, some 30 per cent. of the wheat is not included in the flour. The composition of this residue is given for samples of wheat of different origin, stress being laid upon the importance of suitable mechanical treatment preceding the chemical analysis.—The morphological signification of the caudal vertebræ, by M. Armand Sabatier.—Remarks by M. Faye on the presentation of the sixth volume of the "Annales de l'Observatoire de Nice."—Remarks by M. Darboux on the inauguration of the monument to M. Lobatschevsky at Kazan.—The Committees of Judges were appointed for the Grand Prize of the Physical Sciences, and for the Bordin, Damoiseau, Fourneyron, Pourat, and Gay Prizes.—On the law of variations of latitude, by M. F. Gonnessiat. Results of experiments undertaken with a view of seeing whether the meridian circle, at the same time that it furnished the absolute positions of the stars observed, could not also serve to show the variations of latitude with as much certainty as the differential methods hitherto adopted.—On the problem of Dirichlet, by M. S. Zaremba. An application to this problem of the notation of the theory of electricity.—On the comparative accuracy of the various methods used in securing the vertical in astronomical, geodesic, and topographical observations, by M. Ch. Lallemand. Four methods of levelling were compared—the use of a mercury bath as a plane mirror, the plumb-line, the spirit-level, and the contact of three points with a mercury bath, the last-named having been lately suggested as more rapid and more accurate. As a result of the experiments, supposing in each case the most favourable conditions, the spirit-level was found to be preferable, its accuracy being, in a portable apparatus, about fifteen times that of any of the other methods.—New properties of the kathode rays revealing their complex composition, by M. H. Deslandres. Whenever a kathode ray is deviated by a neighbouring body, it is, at the same time, divided into several distinct rays, which are unequally deviated.—On the partial polarisation of the radiations emitted by some luminous sources under the influence of the magnetic field, by MM. N. Egoroff and N. Georgiewsky. The polarisation in the case of most of the metals employed was shown exclusively in the rays most easily reversed. This was especially marked with copper. The rays from hydrogen and helium have, up to the present, given no definite results.—The part played by peroxides in the phenomena of slow oxidation, by M. A. Bach. In all the cases of slow oxidation by the air examined by the author, the application of reagents for hydrogen peroxide showed that this substance is invariably present. The results of experiments on the oxidising substance produced by the action of air upon palladium charged with hydrogen showed that in this case a higher oxidising power upon indigo than is possible for hydrogen peroxide, and it is suggested that a higher oxide, possibly H_2O_4, is present.—Study of the action of potassium permanganate upon cupric bromide, by MM. H. Baubigny and P. Rivals.—On the constitution of the metallic alloys, by M. Georges Charpy. From the study of a large number of alloys by the micrographical method conclusions are drawn concerning the nature of alloys in general. Eutectic alloys are stated to be not really homogeneous, but to consist of a mixture of the two constituent metals in the form of excessively thin laminæ, which are only visible under very high magnification.—Estimation of the dissolved oxygen in sea water, by MM. Albert Lévy and Félix Marboutin. The method previously adopted with success for ordinary potable water, namely, addition of ferrous oxide in known excess, and subsequent estimation of the excess with potassium permanganate solution, does not give good results in the presence of chlorides, and hence fails for sea water. The replacement of the permanganate by bichromate solution, however, removes this difficulty, the test analyses given being very concordant.—On the combinations of metallic salts with organic bases, by M. D. Tombeck. Aniline and pyridine bases are capable of forming definite combinations with the haloid salts of zinc and cadmium.—On a combination of silver chloride with methylamine, by M. R. Jarry. The compound formed is $AgCl(NH_2.CH_3)$. Its dissociation pressures are given for temperatures ranging from 0° to 65° C.—On the search for naphthol-yellow and analogous colouring matters in white wines and cordials, by MM. Alberto d'Aguiar and Wenceslau da Silva.—The evolutive cycle of the Coccidia in the Arthropods, by M. Louis Léger.—The origins of the vaso-dila or nerves and their trophic centres, by M. J. P. Morat.—On the parallel folds forming the mass of Mount Blanc, by M. J. Vallot.—On the Tectonic of the Nivollet-Revard Chain, by MM. J. Révil and J. Vivien.—On the determination of the proximate composition of the gluten in wheat flour, by M. E. Fleurent. The gluten is separated into two constituents, named respectively glutenine and gliadine, by treatment with a solution of alcoholic potash of suitable strength. The ratio of glutenine to gliadine determines the baking value of the flour.—Researches on the biological action of the X-rays, by MM. J. Sabrazes and P. Rivière.—The postulates of geometry, by M. Léon Fabre.—Influence of the temperature of fermentation upon the amount of nitrogen in wines, by MM. L. Roos and F. Chabert.

AMSTERDAM.

Royal Academy of Sciences, March 27.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Verbeek, on the geology of Bangka and Billiton. Both islands consist of sedimentary rocks, probably of palæozoic age-sandstones, quartzites and shales, broken through by granites. Both of them are covered with quaternary sediments, loose sand and clay, the lowest (perhaps pliocene) strata of which contain tin ore; along the coast are alluvial deposits. The tin ore deposits are newer than the granite eruption, but probably they are not much more recent. Mr. Verbeek next dealt with "the glass-balls of Billiton." In the quaternary or, perhaps, pliocene tin ore deposits of Billiton there occur peculiar, rounded glass-balls with grooved surfaces; they are also found, though very rarely, in certain quaternary tuff strata in Java, and in the equally quaternary gold and platinum mines of south-eastern Borneo. The author classed these objects with the diluvial "Bouteille"-stones (Moldavites) of Bohemia, and the quaternary glass-balls found in Australia, and described by Stelzner (*Zeitschr. d. d. g. Gesellsch.*, 1893, p. 299). The origin of none of these bodies is known. They cannot be of volcanic origin, because the nearest volcanoes are too far distant, and have, moreover, produced glassy rocks of quite a different nature. For various reasons they cannot be artificial either. The author, therefore, took them to be of non-terrestrial origin, and considered it probable that they are thrown out by lunar volcanoes during the quaternary and, perhaps, already during the pliocene period. The author drew attention to the researches of Landerer (*Comptes rendus*, cix. p. 360, and cxi. p. 210), which, it seems, tend to show that a large portion of the surface of the moon consists of acid glass-rocks.—Prof. Hoffmann on the teleneurones in the retina of *Leuciscus rutilus*, in connection with researches by Mr. A. G. H. van Genderen Stort.—Prof. Haga presented, for publication in the *Proceedings*, a paper by Mr. J. W. Giltay, entitled "Polarisation of telephonic receivers." In 1884 the author proved that the speaking condenser required a charging battery to be employed, and that the telephone necessitated the use of a permanent magnet, because otherwise the apparatus renders the sounds to be reproduced an octave too high. The author has lately repeated the experiments with the better microphones of recent times, and found that some condensers (paraffin paper, gutta-percha paper) also speak intelligibly, though disagreeably, without a polarising battery being used, in consequence of the stronger telephonic charges penetrating into the insulator. A mica condenser, without a battery, is perfectly unintelligible. When it has been connected with the battery for a few seconds, it speaks very distinctly, and continues doing so for some seconds after the removal of the battery. When the battery is left in connection with the mica condenser for some time, the polarising action of the battery is found to decrease gradually. After a minute or two the sound has become quite unintelligible. As soon as the battery is removed, the sound immediately becomes very distinct, which, however, lasts only a few seconds. The author cannot yet give an explanation of this phenomenon. A not too tight coil of insulated wire without any iron gives perfectly the same results as a condenser with writing-paper: altogether unintelligible without the battery, quite distinct with it.—Prof. van der Waals gave, on behalf of Mr. Z. P. Bouman, for publication in the *Proceedings*, a survey of the results of an experimental inquiry into the emission and absorption of glass and quartz at different temperatures. The results obtained with the radio-micrometer (in a somewhat modified form) for plates 1 mm. in thickness may be formulated as

follows: The emission curve of glass reaches its maximum at $4.6\ \mu$, shifting but little with temperature. The curves have a broad "flattening" at about $3.5\ \mu - 4\ \mu$. The absorption curve shows the same particularity. The quotient $\frac{\text{emission}}{\text{absorption}}$ yields a curved line, whose maximum lies further towards the lesser λ's, absorption shifting in the inverse ratio to T. The emission and absorption of quartz correspond to each other. The two curves exhibit the same downward bends. In the quotient $\frac{\text{emission}}{\text{absorption}}$ the errors (per cent.) are too great to pronounce a positive opinion.

DIARY OF SOCIETIES.

THURSDAY, MAY 13.

ROYAL SOCIETY, at 4.30.—An Attempt to cause Helium or Argon to pass through Red-hot Palladium, Platinum, or Iron: Prof. Ramsay, F.R.S., and M. W. Travers.—On the Negative After-Images following Brief Retinal Excitation: Shelford Bidwell, F.R.S.—A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media: Dr. J. Larmor, F.R.S.—On a New Method of Determining the Vapour Pressures of Solutions: E. B. H. Wade.—On the Passage of Heat between Metal Surfaces and Liquids in Contact with them: T. E. Stanton.—On the Magnetisation Limit of Wrought Iron: H. Wilde, F.R.S.

ROYAL INSTITUTION, at 3.—Liquid Air as an Agent of Research: Prof. J. Dewar, F.R.S.

MATHEMATICAL SOCIETY, at 8.—On Cubic Curves as connected with certain Triangles in Perspective: S. Roberts, F.R.S.—An Analogue of Anharmonic Ratio: J. Brill.—An Essay on the Geometrical Calculus (Continuation): E. Lasker.—On the Partition of Numbers: G. B. Mathews.—Notes on Synthetic Geometry: W. Esson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Generation of Electrical Energy for Tramways: J. S. Raworth. (Discussion.)—Disturbances of Submarine Cable Working by Electric Tramways: A. P. Trotter.

FRIDAY, MAY 14.

ROYAL INSTITUTION, at 9.—Explosion-Flames: Prof. Harold Dixon, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Zodiacal Radiants of Fireballs: W. F. Denning.—On a New Binary Star with a Period of 5½ Years (β 883): T. J. J. See.—On the Mean Places and Proper Motions for 1900 of 24 Southern Circumpolar Stars: David Gill.—On the Determination of Terrestrial Longitudes by Photography: Captain E. H. Hills.—The Orbit of μ Draconis: S. W. Burnham.

PHYSICAL SOCIETY, at 5.—An Instrument for Comparing Thermometers with a Standard: W. Watson.—An Experiment in Surface Tension: A. S. Ackerman.—The Effect of Temperature on the Magnetic and Electric Properties of Iron: D. K. Morris.—The Formation of Mercury Films by Electric Osmosis: Rollo Appleyard.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MAY 15.

GEOLOGISTS' ASSOCIATION.—Excursion to Chislehurst. Directors: W. Whitaker, F.R.S., and T. V. Holmes. Leave Charing Cross (S.E.R.) at 1.35; arrive at Chislehurst 2.19.

LONDON GEOLOGICAL FIELD CLASS.—Excursion from Snodland to Aylesford, to view the Gault. Leave Cannon Street 2.37.

MONDAY, MAY 17.

SOCIETY OF ARTS, at 8.—Design in Lettering: Lewis Foreman Day.

ROYAL GEOGRAPHICAL SOCIETY, at 2.30.—Anniversary Meeting.

VICTORIA INSTITUTE, at 4.30.—Paper by Dr. G. V. Pope.

TUESDAY, MAY 18.

ROYAL INSTITUTION, at 3.—Volcanoes: Dr. Tempest Anderson.

ZOOLOGICAL SOCIETY, at 8.30.—A Revision of the Lizards of the Genus *Sceloporus*: G. A. Boulenger, F.R.S.—Contributions to our Knowledge of the Plankton of the Faeroe Channel, II.: Dr. G. Herbert Fowler.—Further Contributions to the Knowledge of the Phytophagous Coleoptera of Africa, including Madagascar, Part II.; Martin Jacoby.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Notes on the Working of the Photo-Aquatint Process, and on some of the Apparatus used: T. Huson.

ROYAL VICTORIA HALL, at 8.30.—Adventure in South Africa: F. C. Selous.

WEDNESDAY, MAY 19.

SOCIETY OF ARTS, at 8.—London Water Supply: Prof. Percy F. Frankland, F.R.S.

ROYAL METEOROLOGICAL SOCIETY (Burlington House), at 4.30.—The Rainfall of Dominica, West Indies: C. V. Bellamy.—On the Mean Monthly Temperatures of the British Isles, 1871–95: R. H. Scott, F.R.S., and F. Gaster.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Specimens of Injections of other Objects: Ernest Hinton.

THURSDAY, MAY 20.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture—On the Mechanical Equivalent of Heat: Prof. Osborne Reynolds and W. H. Moorby.

SOCIETY OF ARTS, at 4.30.—Kerman and Persian Beluchistan, with special reference to the Journeys of Alexander the Great and Marco Polo: Captain P. Molesworth Sykes.

CHEMICAL SOCIETY, at 8.—The Theory of Osmotic Pressure and the Hypothesis of Electrolytic Dissociation; Molecular Rotation of Optically Active Salts; Heats of Neutralisation of Acids and Bases in Dilute Aqueous Solution: Holland Crompton.—The Platinum-Silver Alloys: their Solubility in Nitric Acid: John Spiller.—A Comparative Crystallographical Study of the Normal Selenates of Potassium, Rubidium, and Cæsium: A. E. Tutton.

FRIDAY, MAY 21.

ROYAL INSTITUTION, at 9.—Contact Electricity of Metals: Lord Kelvin.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Tunbridge Wells), at 3.—What can be done to save our Fauna and Flora from unnecessary Destruction?: Rev. J. J. Scargill.—How can the Technical Education Grant assist Local Scientific Societies? S. Atwood and J. W. Tutt.—Local Museums: W. Cole.

EPIDEMIOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—The Story of the Earth's Atmosphere: D. Archibald (Newnes).—The Naturalist's Directory, 1897 (Gill).—The Alternating-Current Circuit: W. P. Maycock (Whittaker).—Problems of Nature: Dr. G. Jaeger, edited and translated by Dr. H. G. Schlichter (Williams).—The Fauna of British India. Hymenoptera, Vol. i.: Wasps and Bees: Lieut.-Colonel C. T. Bingham (Taylor).—The Evolution of the Aryan: R. von Ihering, translated by A. Drucker (Sonnenschein).—The Young Beetle-Collector's Handbook: Dr. E. Hofmann (Sonnenschein).—Domestic Science Readers: V. T. Murché, Book vi. (Macmillan).—The Engineer's Sketch-Book of Mechanical Movements, &c.: T. W. Barber, 3rd edition (Spon).—The Vertebrate Skeleton: S. H. Reynolds (Cambridge University Press).—A History of Ancient Geography: H. F. Tozer (Cambridge University Press).—System der Philosophie: W. Wundt, Zweite Umgearbeitete Auflage (Leipzig, Engelmann).—Das Ellenbogengelenk und Seine Mechanik: J. W. Hultkrantz (Jena, Fischer).—Lehrbuch der Zoologie: Prof. R. Hertwig, Vierte Umgearbeitete Auflage (Jena, Fischer).

PAMPHLET.—The Origin of the Celestial Laws and Motions: G. T. Carruthers (Bradbury).

SERIALS.—Strand Magazine, May (Newnes)—Scribner's Magazine, May (Low).—Journal of Anatomy and Physiology, April (Griffin).—Imperial University, College of Agriculture, Bulletin, Vol. iii. No. 1 (Komaba, Tōkyō).—Journal of the Royal Microscopical Society, April (Williams).—Atlantic Monthly, May (Gay).—Fortnightly Review, May (Chapman).—Geographical Journal, May (Stanford).—Bulletin of the American Mathematical Society, April (New York, Macmillan).—American Journal of Mathematics, Vol. xix. No. 2 (Baltimore).—American Journal of Science, May (New Haven).—Proceedings of the Physical Society. Vol. 15, Part 5 (Taylor).

CONTENTS.

THURSDAY, MAY 20, 1897.

A PHILOSOPHICAL THEORY OF SELECTION.

Versuch einer philosophischen Selektionstheorie. Von Dr. Johannes Unbehaun aus Gotha. Pp. 150. (Jena: Gustav Fischer, 1896.)

THE object of this essay is to place the theory of selection on a purely deductive and abstract basis as distinguished from the concrete form in which it is made familiar to modern evolutionists through the writings of Darwin and Wallace. From the philosophical point of view, it is certainly desirable that we should realise that the particular kind of selection which is operative in species transformation, or in the production of artificial races, is only one phase of selection in the abstract, and any attempt to make our ideas on this subject more exact will be welcome to philosophical students of evolution. It is, in fact, somewhat remarkable that, while all working naturalists have now accepted the doctrine of evolution in one form or another, comparatively few have attempted to examine into the philosophical basis of the principles of selection. Dr. Unbehaun's discussion of the subject, if not exhaustive, is at any rate very suggestive, and as a contribution to a much neglected aspect of the philosophy of evolution the work may be safely recommended to English biologists.

The opening part of the essay, which treats of the principle of selection from the historical point of view, offers very little novelty. The author comes to the conclusion that the germ of the modern theory of selection is contained in the writings of the Greek philosophers. Empedocles appears to have had some hazy notions of the kind which did not produce much effect upon Aristotle, and the first definite utterance is attributed to Lucretius Carus the Epicurean. Those who take pleasure in reading into the poetic flights of ancient writers the discoveries of modern science, will derive interest from this section. There was a time in the history of science—especially in this country—when no new discovery was considered worthy of credence unless it could be shown to be in harmony with the views of the old philosophers. Those were the days when classical studies reigned supreme in our Universities, and when the would-be student of science was looked down upon as a poor creature. Happily for us the times have changed, and no worker in science is now seriously influenced by what the ancients thought. If he studies their writings, it is more from the point of view of academic interest than from a desire to find justification for his discoveries. The author of the present work does not appear to be acquainted with Prof. H. F. Osborn's most interesting discussion of the history of evolution in his book entitled "From the Greeks to Darwin."

As founders of the modern theory of selection, Dr. Unbehaun justly couples Darwin and Wallace. The distinction between evolution or descent with modification and selection is clearly grasped and emphasised by the former being called "Lamarckismus," and the latter "Darwinismus." Some pages are devoted to an exposition of the Darwinian principles, and the limited theory of selection elaborated by Malthus is also explained. There are not many points in this section with which we are not already familiar in this country, but the author certainly puts the case in a way calculated to clarify some of the current notions concerning the action of selection. Thus, with respect to the interpretation of the term "struggle for existence," it is pointed out that there are three possibilities, viz. struggle unaccompanied by actual extermination, and therefore of no effect as a selective process; struggle with extermination, as in ordinary natural selection; and extermination without struggle, which may or not produce selective action. The consideration of this last contingency brings out very clearly the difference between the struggle of competing organisms among themselves and the struggle with external (inorganic) conditions of environment. The outcome of this discussion is the conclusion that concurrent extermination of individuals or races is indispensable for the process of selection—in other words, that selection is concerned only with the existence or non-existence of individuals or assemblages of individuals, whether actual or potential.

After a brief exposition of the extension of the idea of selection from the organism as a whole, to the component parts (Wilhelm Roux, 1881), the author discusses palæontological selection, a subject which appears to be equivalent to a consideration of the conditions which favour the preservation of fossil remains, and for the complete understanding of which it is essential to study the conditions of preservation and destruction of animals and plants going on at the present time. In connection with this, there is brought forward a principle which is termed lithogenetic selection (Johannes Walther, 1895), and which may be paraphrased by saying that, although a geological formation may be laid down over a wide area of the surface of the earth, the local preservation of the rock material is determined by local conditions, organic and inorganic. The attempts which have been made to refer the processes of evolution in inorganic nature to the action of selection in any form, are considered by the author to have failed on account of the untenability of the fundamental assumptions. After a summing-up of the conditions essential for the formulation of a philosophical theory of selection, the author discusses, in an appendix, some further points of historical interest; viz. the claims of Herakleitos among the ancients, and of Kant and Wells among modern writers, to have entertained the idea of a struggle for existence. The utterances of the Greek philosopher are considered hazy; those of Kant and Wells are, as Haeckel has already shown (1889), more to the point.

The real work of building up "a purely deductive theory of selection on the most general foundation" begins in the second chapter, and selection is defined (p. 34) as the process by which, out of a number of objects which are in any way related to each other, some undergo extinction, while others survive within the same interval of time. A critical analysis of this conception leads to the conclusion that, instead of through selection, it is possible to approach the problem from the point of view of a system of objects (organisms) having different degrees of duration in time. Here, again, there may be selection with or without further development, according as the process is accompanied by renewal or not. In the latter case, a system may become modified in its average

characters through selection by the mere persistence or survival of residues. If the process of selection continues, the system will ultimately disappear altogether. In the case of selection with renewal the system does not undergo extinction, and, therefore, this is regarded as the more general case, since selection without renewal may be regarded as the limiting case in which the number of renewals is always equal to zero. The consideration of the mode of renewal by the origination of new objects within the system is followed by a mathematical discussion extending over several pages, and leading to a further elaboration of the idea of selection.

The idea of adaptation in the abstract is next discussed, and the conclusion arrived at is that between an object and its environment there may be three kinds of adaptation; viz. by a modification of the object itself to an unchangeable environment, by a modification of the environment by an unchangeable object, and by mutual adaptability when both are changeable. Following this, there is a discussion of certain special cases of the abstract theory of selection, and some very suggestive observations are made with respect to the difference between selection due to mere survival, and selection due to survival accompanied by actual picking out. The point is a fine one, but it appears to be philosophically sound; and the author introduces a term to express the latter, which might be conveniently translated into "progressive" (*fortschreitende*) selection. A mathematical appendix to Chapter ii. discusses the relations between the three magnitudes: (1) the number of objects present at a given period of time; (2) the number of renewals; and (3) the number of extinctions, on the assumption that the number of renewals is determined by the number of objects already present.

The concluding chapter deals with the limitations of the principle of selection and its consequences, and the introduction of the abstract results into concrete cases. Most instructive is the section in which the author points out the inapplicability of the principle of selection which governs the organic world to inorganic nature, such as the development of astronomical systems or to the formation of chemical compounds. The author deals very severely here with Carl du Prel, who appears to be responsible for an attempt to introduce the idea of the struggle for existence into the formation of the heavenly bodies. One of the main contentions of the present essay is, in fact, that while the organic world is entirely governed by the principle of progressive selection, the evolution of inorganic nature can be referred to no such principle.

The essay, of which a very brief account has now been given, will find a place in the literature of the philosophy of evolution. It deals with the question only on very broad grounds, and does not appeal, therefore, to special schools of evolutionists, or to special biological creeds beyond the school of pure selectionists. In this principle of selection the author sees a universal law of development for organic nature, which can be made the basis of a positive philosophy of evolution. He recognises the part played by Herbert Spencer, although reserving to himself the right of being sceptical with respect to Spencer's developmental machinery. Dr. Unbehaun's position is, perhaps, best defined as an attempt to recast the "Synthetic Philosophy" on purely Darwinian principles. It must be borne in mind that, in commending the work to the notice of English readers, we have not the scientific specialist in view. There is no new discovery of fact announced, and most of the principles are already familiar to English students of evolution. The essay is a contribution to philosophy rather than to science. It is the mode of treatment—the manner of presenting the case—that constitutes the chief value of the essay. The endeavour to formulate the principles of selection in exact terms capable of mathematical expression is being made from many sides, and, as a method of attacking such questions, has for some time found favour in this country. It is somewhat surprising, however, to find that no reference is made by the author to the work of Francis Galton and Prof. Karl Pearson, who have done more in this direction than any other writers.

R. MELDOLA.

ILLUSTRATED HISTOLOGY.

A Text-book of Histology: Descriptive and Practical. For the use of Students. By Arthur Clarkson, M.B., C.M.Edin. Pp. xx+554; with 174 original coloured illustrations. (Bristol: John Wright and Co. London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1896.)

A BOOK which is illustrated in so lavish a manner as the one before us, is calculated to catch the eye; but it must also bear the test of critical examination. By its coloured representations of the tissues, it challenges comparison with the well-known "Atlas of Histology" of Klein and Noble Smith, which was published some seventeen years back. Except, however, that it is smaller and less costly, it suffers grievously by the comparison. Klein's "Atlas" contained accurate representations made from preparations which were thoroughly up to date, and their description included much that was at that time new; so that the whole work had an unmistakable air of originality, and has remained of permanent value. The book before us has pictures which are pretty, as far as gaudy colouring can make them so, but which are, many of them, sadly lacking in accuracy of detail, or have been made from preparations fixed by imperfect methods. The very first figures we come to in the book furnish an illustration of this statement. In the representation of the stages of karyokinesis, the monaster stage is shown with nine chromosomes, each splitting into two. In a succeeding figure of the same stage their number is reduced to eight, and in the following two figures, representing the stage of metakinesis of the nucleus, we find, respectively, eight and ten chromosomes instead of eighteen in each! Then, again, in such a simple figure as the representation of human blood-corpuscles a spherical white corpuscle is represented of, at least, twice the diameter of the red corpuscles; while in the drawing of newt's blood, amongst a number of distorted red corpuscles, and some impossible white cells and blood platelets, a non-nucleated fragment of a white corpuscle is inserted, as if it were a normal constituent! The author expresses his obligations to Prof. Rutherford for having taught him the art of constructing histological diagrams. We

wonder what Prof. Rutherford's feelings will be when he sees the diagram of two liver lobules, which is presented in Fig. 121.

Not that we, by any means, wish to imply that all or even most of the illustrations are of the character above specified. On the contrary, if we put aside accuracy of detail, many give a representation of ordinary microscopical objects which will rejoice the heart of the average student, because he will find that his preparations are "just like the drawings," *i.e.* as long as he sticks to the stereotyped methods which are customary in certain histological courses. And this is the key-note of the practical directions which are given in the text. A few common methods of general applicability, such as have been employed with occasional modifications for the last twenty years, are described, but many of the most valuable modern developments are conspicuous by their absence. We look in vain for the methylene-blue[1] method of Ehrlich for showing nerve-endings, the invaluable method for tracing degenerating nerves described by Marchi, the bulk-staining method of Heidenhain. The student is not taught how to examine each tissue in the fresh condition, but dependence is almost entirely placed upon sections and stained preparations. Formol is not even mentioned, although it has been for at least three years in constant use by histologists. These are faults of omission which cannot be excused by the statement in the preface that "only the well-known and well-tried methods are given." The above are all well-known and well-tried methods, and all students of histology ought to be familiar with them. Nor are faults of commission lacking. We are told that a tissue treated with nitrate of silver, and exposed to good daylight, requires for staining "a few hours to a day or two"; whereas every histologist knows that a few minutes under these circumstances is abundantly sufficient. The gustatory nerve-fibres are shown continued into the central ends of the gustatory cells. It is stated to be "not as yet very clearly decided as to whether the cylinder cells, the rod cells, or both, are to be regarded as the peripheral terminations of the olfactory nerve." The lens is described as "somewhat lozenge shaped"; and so on.

It is not a little remarkable that a work of this sort, lacking, as it does, the first principle of a text-book, accuracy, and compiled, as it acknowledgedly is, largely from other text-books, should have been the subject of numerous eulogistic notices in the medical, scientific, and even in the public press. One would hardly expect the *Scotsman* to think that the plates "represent what ought to be seen in perfect specimens," and the *Western Daily Press* to find that "the details are specified with a delicacy and microscopic accuracy which reveal innumerable anatomical beauties"; and it is somewhat surprising that another reviewer finds "the semi-diagrammatic representations of liver" (!), amongst others, "very helpful," and yet another hails the work as "an important contribution to histological literature." We can only regret that we have been unable to endorse these and many other expressions of opinion of an equally favourable character, which have been forwarded to us. For, in fact, the only part of the subject which bears any indication of having been specially studied by the author is that dealing with the ductless glands, especially the hæmal glands and the suprarenal capsules, and this shows a marked superiority of treatment. Had the whole book been written in the manner in which this part has been done, such eulogies might, perhaps, have been justifiable; but, as this is not the case, they entirely overshoot the mark, and can only lead to a feeling of disappointment on the part of the reader.

[1] The author is apparently unaware that methyl-blue and methylene-blue are two entirely different substances and have different histological uses, for he constantly uses the term methyl-blue where methylene-blue would be appropriate.

STUDIES ON EARLY MAN.

Studies in Ancient History. By J. F. M'Lennan. Second Series. Pp. xvi + 605. (London: Macmillan and Co., Ltd., 1896.)

IT is now many, many years since Mr. M'Lennan came before the public as an expounder of the beliefs and habits of early man, and we think that no one will deny to him the credit of having brought a trained mind and good powers of reasoning and deduction to his work. More than this, it must be admitted that he collected his facts with great care, and that although some of his results have not stood the test of time, they have at least served as finger-posts to point others to the right paths. More than twenty years have gone by since the first series of his "Studies in Ancient History" saw the light, and twenty years in the science of anthropology and its cognate subjects represent a vast amount of progress in these times. It was evident to Mr. M'Lennan himself that some of his views would have to be modified by the results of other workers, and though, alas, he never lived to re-edit a second edition of the "Studies," he was fortunate enough to have found a sympathetic supporter in his brother Mr. D. M'Lennan, who not only published as "a preliminary and polemical inquiry" "The Patriarchal Theory," but also a second edition of the "Studies" with notes by himself. Soon after this Mr. D. M'Lennan was himself carried off by death, and the late Prof. W. R. Smith undertook to finish the work which the two brothers had begun. About this time, however, Prof. W. R. Smith was deeply engaged in the study of Oriental kinship and marriage, and totemism, and he was also planning his series of lectures on "fundamental institutions"; it is evident that he had little leisure in which to arrange the labours of other workers. That little leisure, moreover, was broken in upon by the increase of the malady which subsequently caused his death, and as a matter of fact he left M'Lennan's work pretty well as he found it. Mrs. M'Lennan then determined to attempt the publication of all papers that were at all in a fit state, and she was fortunate enough to find not only a willing, but a most able friend in Mr. A. Platt, who as long as she lived assisted her in the work, and when she was dead, completed the labour of love which she had begun.

The second series of the "Studies" is divided into two parts; the first relates chiefly to kinship, totemism, marriage, the origin of exogamy, female infanticide, &c., and the second to the customs of the peoples of the Pacific Islands, America, Africa and Australia in these matters. Of the various chapters, only that on the

"Origin of Exogamy" has hitherto been printed. The reader will find during the course of his perusal of this volume that he is already familiar with a large number of the facts, and will be inclined to wonder why they are reproduced here without reference to the works in which they have already been printed; but it must be remembered that the works of W. R. Smith, Frazer and others have been published since the death of M'Lennan, and to add references of this kind was clearly outside the duties of the editors. Again, some of his views are given more fully, and others are disproved by an overwhelming mass of evidence in the splendid publications of the American Bureau of Ethnography which the Government of the United States have issued during the last fifteen years; but we cannot blame the editor for being silent on these points. M'Lennan began to work and to collect materials when the study of comparative ethnography was in its infancy, and he endeavoured to study everything for himself and at first hand. As other workers entered the field, and studied to specialise their knowledge, his task became greater and greater, until at length he was unable to cope with it; still in many respects his work is thorough, and even when his impressions and deductions from facts are wrong, they bear an honesty about them which is lacking in the work of more modern investigators. In a book dealing with so many peoples and countries it would be easy to pick holes and to raise an argument with tolerable frequency; and although we do not propose to do either the one or the other, still we must protest against the quotation on p. 520. Here it is gravely stated that the Zodiac was known in Egypt as early as B.C. 5800, but there is no evidence whatever extant on which to found such a decision; the home of the Zodiac was the country lying to the north-east of the Arabian Peninsula, and though it may have been known to both the Semitic and non-Semitic inhabitants of this region at such an early period, there is no proof that it was. Finally, we cannot help regretting that Mr. M'Lennan's "Studies" are without an index, for, in our opinion, one-half of their usefulness and value is lost thereby.

OUR BOOK SHELF.

Ferrets, their Management in Health and Disease; with Remarks on their Legal Status. By Nicholas Everitt. 12mo, pp. xv+209. Illustrated. (London: A. and C. Black, 1897.)

PROBABLY many of our readers who have not been brought up in the country would be shy of handling a ferret; but if they attend carefully to the directions given in this little volume, they may set aside their fears for the future. Admirable instructions are also given as to the management of these animals in health and in sickness, and likewise how to use them in the field; while a *résumé* of the legal status of ferrets will probably be useful to many. So far, indeed, as the breeding and management of these little mustelines are concerned, we may say, to use an expression of the author, that "what he does not know is not worth knowing."

Unfortunately, in common with many writers of works of a similar kind, the author has thought it necessary to give a preliminary chapter on the natural history of the ferret. Here he is in hopeless confusion. Although he describes the ferret as a species of *Mustela*, he says that it belongs to the genus *Putorius*; and further informs us that it is a natural species, whose native home is Africa. He also states that the beech, or stone marten, is a British species, and makes several remarkable assertions concerning other members of the group. The author may be reminded that there are writers on natural history since Buffon; and should the work reach a second edition, he would do well to engage the services of a competent naturalist to rewrite the first chapter. R. L.

Catalogue of the African Plants collected by Dr. F. Welwitsch in 1853-61. Part i. Dicotyledons. By W. P. Hiern. Pp. xxvi + 336. (London: Printed by order of the Trustees of the British Museum, 1896.)

DR. WELWITSCH, although an Austrian by birth, occupied the position of curator of the Lisbon Botanic Garden and Museum, when he was selected, in 1851, by the King of Portugal as naturalist to an expedition for exploring the Portuguese possessions on the West Coast of Africa. Between this date and 1861, he made very large collections, chiefly of plants. Although Dr. Welwitsch died in 1872, his collections have till recently remained unedited, partly owing to a dispute as to their ownership between his Trustees and the Portuguese Government, which ended in the Court of Chancery, partly owing to the difficulty in finding a compiler and editor. This office was finally placed, by the Trustees of the British Museum, as far as the flowering plants are concerned, in the very competent hands of Mr. W. P. Hiern, who has now brought out the first part, comprising the natural orders of Dicotyledons from Ranunculaceæ to Rhizophoraceæ. The work has been one of great labour, a large number of new species and some new genera being described; and we may congratulate the systematic botanist on so important an addition to our knowledge of the flora of Tropical Africa.

A. W. B.

Pioneers of Evolution from Thales to Huxley; with an Intermediate Chapter on the Causes of Arrest of the Movement. By Edward Clodd. Pp. x + 250. (London: Grant Richards, 1897.)

MR. CLODD has produced an interesting book, in which is told "the story of the origin of the Evolution idea in Ionia, and, after long arrest, of the revival of that idea in modern times, when its profound and permanent influence on thought in all directions, and, therefore, on human relations and conduct, is apparent." The volume is divided into four parts, which deal successively with the Pioneers of Evolution from Thales to Lucretius, the Arrest of Inquiry, the Renascence of Science, and Modern Evolution. It should be read by the great body of science students in our University Colleges and technical schools, who, too often, in following special branches of science, lose sight of the great generalisations which have, during the latter part of this century, so completely altered the complexion and tendency of ideas on every subject of thought.

The author sketches the chief results which have come from the recognition of the principles of evolution, not only in biological provinces, but in all departments of human knowledge; and he has, in so doing, produced an attractive and wonderfully clear little volume.

It may be worth while to point out that the statement that nebulæ are "masses of glowing hydrogen and nitrogen gases" (p. 164) needs correction; for nitrogen, as a nebular constituent, is now relegated to the limbo of departed ideas. Mr. Clodd should have verified his statement by himself taking the advice which he offers Lord Salisbury on p. 165. The reference to "the complex jelly-like *protoplasm*, or, as some call it, *nuclein* or *nucleoplasm*" (p. 103), also needs to be made accurate, for in its present form it will give readers the idea that the three words we have italicised are synonymous. The book contains good portraits of Darwin, Russel Wallace, Herbert Spencer, and Huxley.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Immunity from Mosquito Bites.

WITH the mosquito as he is, and as he has been for forty-six years. in the territory on both sides of the Mississippi River from Memphis, Tenn., to New Orleans, and along the Gulf of Mexico for five hundred miles, in the cypress swamps, palmetto and cane-brakes, on the lower river lands, winter and summer, following my business of telegraphy, I am intimately acquainted; and from this long and varied experience can say definitely for myself that I have no immunity from their attacks. Every bite yesterday, or forty-six years ago, produced a wound, generally a white, callous swelling from one quarter to three-quarters of an inch in diameter, and as high as a quarter of an inch, which remains forty-five to sixty minutes, with more or less pain in all, and fever in many cases. And this whether it was the bite of the fierce gallinipper of the swamps, which stings through a flannel shirt, or the little zebra-legged thing—the shyest, slyest, meanest and most venomous of them all—which invades the heart of the city, away from the foliage, the common haunts of the other varieties.

While I have to be vigilant in warding them off, my children sitting around are comparatively undisturbed, and other people suffer nothing from them; so it seems the mosquito has the power of selection.

But if I have experienced no immunity from mosquito poison, I have enjoyed it other ways, which it may be interesting to state. When I qualified as an operator in Mississippi, I was given a station to which was attached fifty miles of wire, which I was to keep in order, repair breaks, remove leaks, and replace insulators. The line was mostly on trees, few poles being used, and the foliage, including vines, had to be kept down. The latter were especially dangerous and of rapid growth, and among them was the *Rhus toxicodendron*, but I knew nothing of its qualities; and when I came across it, which I did at the very outset, I cut it at the roots, and taking hold of it with naked hands, pulled it off the trees and poles without ever experiencing the least effects from it. Others are poisoned by its touch, and are laid up for weeks and months, their sufferings being produced by periodical eruptions appearing annually on the hands, face or neck for many years. DAVID FLANERY.

Memphis, Tenn., U.S.A., April 28.

Identical Customs of Dyaks and of Races around Assam.

THE deplorably backward state of anthropology in England and India is effectually exposed by the recent publication of Mr. Ling Roth's "Natives of Sarawak and British North Borneo." Beautifully illustrated, exhaustive in treatment, too expensive to be procurable among working students, and exasperatingly unweildy, it is a monument of shame to us, as a race; the more so when we see that only 700 copies are to be issued, "no cheaper edition" *guaranteed!* and the beautiful plates to be destroyed!

As a record of our apathy and ignorance it could hardly be surpassed. Here is a really wonderful work, lavishly got up, two huge volumes full of the most valuable matter, quoted from the best authorities, unlimited speculation as to where these races came from, and as to how some of their singular customs arose, such as "head-hunting," &c., and, as far as I can see, not the faintest suspicion that these customs came, with the race itself, from Assam.

The late Captain Otto E. Ehlers, with whom I spent ten days here in the early part of 1895, was so impressed with the fact, at last, that these Abor-Noga savages around Assam are the race stock whence the Batta-Dyak developed, that he determined to first examine and collect among our groups, and later on visit Borneo. With this object in view we visited together some of the eastern Nogas. He then went among the little-known "Apa Tanangs," and later on the "Nogas" along the south border, "A-nga-mi" and others, making huge collections. Unfortunately he contracted fever, and was ordered off for a long sea voyage, intending to visit Papua so as to collate the races there, closely allied to our Kol; and had intended taking Borneo on the return voyage. His untimely death in Papua put an end to it all, and what has become of his notes and collections I do not know. This, however, I can vouch for, *i.e.* that he was thoroughly convinced that in and round Assam we have a huge mine of anthropological lore, of which our men of science have not the faintest suspicion, and to which fact I have now for some years in vain endeavoured to draw attention.

In reading Mr. Ling Roth's work, it becomes at last almost wearisome to note the identity of the Bornean customs with those of our semi-savage races, down even to trivial details, the only marked differences being those due to developments through contact with more advanced races *later on*, such as the early and pre-Musalman, and Brahmanical influences, *viâ* Java. One of the greatest stumbling-blocks in collating our races with those of the Archipelago is the persistence with which languages are looked upon as the main tests of racial affinity. Occasionally language is invaluable, but at other times, as in this case, it stands a bad second, or even third, both custom and physique being more reliable. We often have curious proofs of this even here, on a small area. For instance, I am now endeavouring to get a collection of the peculiar armless fringed jackets worn by the men among E. Nogas, Mishmi, Miri, Apatanang, Mikir, Kasia, Garo, Kuki, &c. I have seen these being woven by Noga women, the loom simply two sticks in the ground, with a cross-piece (Fig. 1, A), to which the narrow web is attached; another stick, B, at about six feet distant from A, and over which the threads pass, is held tightly by a strap and strings which pass round the weaver's back, as she sits on the ground.

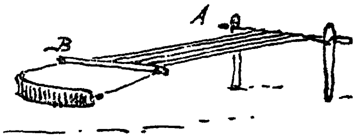


FIG. 1.

The small piece of cloth when finished, with patterns often woven in of coloured cotton or goat's hair, is some 4 feet long by 8 inches or 10 inches wide. The ends of threads form a fringe, thus (Fig. 2):—

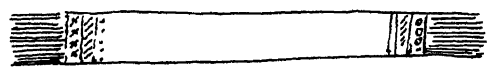


FIG. 2.

Now, two of these pieces are sewn together, so as to leave a hole in the centre (Fig. 3);

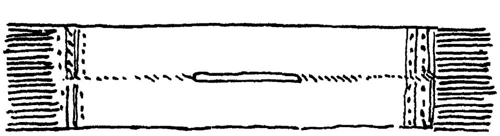


FIG. 3.

and then, after turning over, are sewn down the sides, so as to leave arm-holes (Fig. 4).

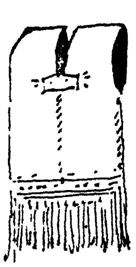


FIG. 4.

The whole thing is too methodical, and identical, to be an accidental resemblance—all are practically alike in details of construction; yet we not only find this jacket among all these tribes, but among the Dyaks, a proof (among many others) that, as a racial relic, it is *older than the languages* of these races around Assam.

But the lists of identical customs, seen between these races here, and those in Borneo, from "head-hunting," and its causes, building on piles, tatooing, &c., down to such trivial details as the value attached to the hornbill's feathers, curious fences, is interminable, quite impossible to put in a letter.

What I desire to point out is the need for systematic research among these races around Assam and in the ultra-Indian peninsula; they are practically unknown to anthropologists, and unless soon taken in hand, a vast amount of most valuable history will

be lost for ever. Some of the most valuable racial curios are now actually unprocurable. The long straight swords of the Mishmi, in the extreme east, were formerly found among all the races north of the valley as far west as the Kuki, and are now a tradition only. The Noga "Kyep," hide cuirass, identical with that of the Niasi, west of Sumatra, are impossible to get hold of, though common here thirty years ago—firearms rendering them useless.

An organised army of intelligent workers is badly wanted to save the stores of unwritten history seen in *customs* among all these races. They are pre-Aryan races, and if but a tenth of the time and money now being lavished on the Aryan remains, here and at home, were devoted to these far older, and far more interesting races, the result would astonish home folk. The races of the Pacific, and Archipelago (Australia included), came from India, as Polynesian investigators well know, but cannot easily join the proofs across the Malayan region.

Can nothing be done to arouse attention to this matter? Some of the customs are of the greatest possible value in the elucidation of the development of early human institutions such as marriage; and in the *Journal* of the Asiatic Society of Bengal, vol. lxi. pt. ii., No. 3, 1892, pp. 246 to 269, I drew attention to one of them in "The communal barracks of primitive races," a vast subject, on which alone there is enough to occupy many experts for several years, as its ramifications extend from West Africa to Eastern Polynesia, and from the Himalaya to New Zealand.

There are many willing and capable workers in the East, but scattered over a vast area; a central "association" is needed, say at Singapore, to and from which communication is easy. An association of scattered students, rather than a new society, is wanted, and it would cost very little if the local branch of the Asiatic Society took the matter in hand as a branch of its work, charging those engaged in research a transmission fee on all that passes.

At the present moment I am most anxious to get in touch with some one in Formosa, so as to procure photos of the savages, their houses, &c., to compare with our Noga, who, I believe, are the same race stock, but I am not able to get the names and addresses of workers there; a central association at Singapore could very probably afford help in such matters.

The Anthropological Institute of Great Britain and Ireland is too far off to give this aid; besides, it is not a live society, or anthropology would not be in such a pitiable slough as we see it here. The collection of life-sized nude nondescript effigies in the Indian Museum reveals our state at a glance; they are to amuse the hundreds of natives who gape at them daily. The value of it as a collection is measured by the *numbers* who stare and get thoroughly mystified, and this is proudly published every week. As an ethnological collection it is enough to drive an expert mad. S. E. PEAL.

Sibsagar, March 31.

A Curious Luminous Phenomenon.

THE phenomenon mentioned on p. 31 of NATURE (May 13), is undoubtedly subjective, and has to do with the fatigue of the retina.

I observed it very markedly in the case of an orange round which I was skating on the open-air ice-rinks in the Engadine; all the country about being white, and the ice, too, being dazzling.

The blue-violet margin to the orange was zero, or at a minimum, when I fixed my eye on a point on the orange. It was at a maximum when I glanced quickly round the orange, or when the orange rolled. In the latter case it was unsymmetrical and "trailed."

I satisfied myself, by the experiments that I tried, that the portion of the retina protected from the white glare by the image of the orange, received an impression of blue-violet light when the protection of this image was removed owing to the movement of the eye or of the object; but that this peculiar condition of the portion of the retina in question was very transitory.

It is possible that temperature affects the phenomenon indirectly; since the eye may be more unsteady, and wander more, when the temperature is low.

Experimenting in England with less white and dazzling ice and landscape I found the phenomenon less marked. It was very brilliant and beautiful in the Engadine.

I feel sure that if any observer notices the effect of keeping his eye fixed on some point of the body so as to keep the image on a constant portion of the retina, he will come to the same conclusion as myself. W. LARDEN.

R.N.E. College, Devonport.

Röntgen Rays.

I HAVE had a focus-tube constructed, in which the distance between the electrodes can be varied, after Mr. Campbell Swinton's pattern, but in which the kathode is made the movable electrode, and the adjustment is made by magnetic control. This is effected by attaching a disc of soft iron to the sliding-rod of the kathode. The advantage of this arrangement is that the kathode can be moved up to, or away from, the anode while the tube is working, so that the best effect can be at once obtained. The resistance is, as Mr. Swinton has pointed out, greater when the electrodes are close together than when they are far apart. The best fluorescent effects are, however, obtained when the electrodes are so close together (about one millimetre apart) that a very bright arcing discharge occurs between them. The screen is now lighted up much more brilliantly than when they are at any other distance apart. The very bright fluorescence is only obtained when the arcing discharge occurs. If the electrodes are brought any nearer together, the platinum anode becomes red-hot, the fluorescence fails, and the resistance of the tube increases very rapidly. I do not remember having seen this noted before.

Edinburgh, May 10. DAWSON TURNER.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following are the names and qualifications of the fifteen candidates selected by the Council of the Royal Society, to be recommended for election into the Society this year:—

ROBERT BELL,

M.D., B.A.Sc., LL.D. Assistant Director of the Geological Survey of Canada. Has been actively engaged in the field work of the Survey for thirty-six years. Was concurrently Professor of Chemistry and Geology, Queen's University, Kingston, for five sessions, 1863–68; Naturalist and Medical Officer on the Government Expeditions to Hudson Bay, 1884–85; Royal Commissioner on the Mineral Resources of Ontario, 1888. Distinguished for his services to Canadian Geology, having worked over large sections of the Dominion east of the Rocky Mountains. Has made extensive researches among the Laurentian and Huronian Rocks, and in reference to Glacial phenomena. Has added materially to our knowledge of Zoology and Botany—more especially of the Forestry—of Canada. Has published nearly 100 reports and papers of a scientific character. They include upwards of twenty reports, some accompanied by maps of the Geological Survey, between 1857 and 1890, giving the results of geological and topographical surveys and explorations on both sides of Hudson Bay and Straits, along the principal waters between the upper Great Lakes and James Bay, and of those between the Winnipeg Basin and Hudson Bay, the first survey of Lake Nipigon, geological surveys of the Canadian Sudbury Mining Districts, the Gaspé District, the Lake Peninsula of Ontario, and in other parts of the extensive regions of Canada. Although much condensed, these Reports cover about 930 pp. royal 8vo. Among many additional publications may be mentioned "The Causes of the Fertility of the Land in the Canadian N.W. Territories," "The Petroleum Field of Ontario," "The Huronian System in Canada," "Glacial Phenomena in Canada," "The Geology of Ontario, with special reference to Economic Minerals," "The Laurentian and Huronian Systems North of Lake Huron," "The Origin of Gneiss," "The Forests of Canada," "The Forest Fires in Northern Canada."

Supplementary Certificate.—Since the date of the above certificate Mr. Bell has made further geological investigations of importance north of Lake Huron, and a survey of a large river previously unknown to geography in the country south-east of James Bay, besides a general geological and topographical exploration of an extensive area in that region. He has now been connected with the Geological Survey of Canada for forty years,

and has published 135 scientific papers, reports, &c., besides abstracts of 42 others read by the author. The titles of most of these are published in the *Transactions of the Royal Society of Canada for* 1894.

SIR WILLIAM HENRY BROADBENT,

F.R.C.P. Physician in Ordinary to H.R.H. the Prince of Wales. Consulting Physician to St. Mary's Hospital, and to the London Fever Hospital. Late Lecturer on Medicine, St. Mary's Hospital. Late Senior-Censor of the Royal College of Physicians. Late President of the Harveian, Clinical, and Neurological Societies. Late Examiner in Medicine, University of Cambridge, University of London, and at the Royal College of Physicians of London. Is very eminently distinguished as a physician, and is the author of numerous important Memoirs bearing upon the Physiology and Pathology of the Nervous System and the Heart; and also upon scientific principles of Therapeutics. The following are some of his principal contributions:—"The Sensory Motor Ganglia and Association of Nerve Nuclei" (*Brit. and For. Med. Chir. Rev.*, 1866); "On the Structure of the Cerebral Hemispheres" (*Proc. Roy. Soc.*, 1869); "On the Cerebral Mechanism of Speech and Thought" (*Trans. Med. Chir. Soc.*, 1872); "An Attempt to apply Chemical Principles in Explanation of the Action of Remedies and Poisons" (London, 1869); a work "On the Pulse" (London, 1890); Lettsomian Lectures, before the Medical Society, on "Syphilitic Diseases of the Nervous System," 1874; Harveian Lectures, before the Harveian Society, on "Prognosis in Valvular Disease of the Heart," 1884; Croonian Lectures, before the Royal College of Physicians, on "The Pulse," 1887; Lumleian Lectures, before the Royal College of Physicians, on "Structural Diseases of the Heart," 1891. Numerous other papers have been published in the Medical Journals and Transactions of the Medical Societies.

CHARLES CHREE,

D.Sc., M.A. (Cantab.). Superintendent of the Kew Observatory. Author of the following Memoirs, and many others on analogous subjects:—(1) "Effects of Pressure on the Magnetisation of Cobalt" (*Phil. Trans.*, 1890); (2) "Stresses and Strains in Isotropic Elastic Solid Ellipsoids," &c. (*Proc. Roy. Soc.*, 1895); (3) "Conduction of Heat in Liquids" (*ibid.*, 1887); (4) "A Solution of the Equations for Equilibrium of Elastic Solids," &c. (*Camb. Phil. Trans.*, vol. xv.); (5) "On some Compound Vibrating Systems" (*ibid.*, vol. xv.); (6) "Changes in Dimensions of Solids due to given Systems of Forces" (*ibid.*, vol. xv.); (7) "The Isotropic Elastic Sphere and Spherical Shell" (*Camb. Phil. Trans.*, vol. xv.); (8) "Forced Vibrations in Isotropic Elastic Solid Spheres and Spherical Shells" (*ibid.*, vol. xvi.); (9) "Rotating Elastic Solid Cylinders of Elliptic Section" (*Phil. Mag.*, 1892); (10) "Contributions to the Theory of the Robinson Cup Anemometer" (*Phil. Mag.*, 1895); (11) "Longitudinal Vibrations of Acolotropic Bars with One Axis of Material Symmetry" (*Quart. Journ. Math.*, 1890); (12) "Isotropic Elastic Solids of nearly Spherical Form" (*Amer. Journ. Math.*, vol. xvi.).

HENRY JOHN ELWES,

F.L.S., F.Z.S. President of the Entomological Society (1893–94). Vice-President of the Horticultural Society (1878-80). Late Captain, Scots Fusilier Guards. Has for many years devoted himself to the study of Ornithology and Entomology, and has travelled extensively with the view of investigating the migrations, variations, and geographical distribution of birds and certain classes of insects over large areas of the northern hemisphere. In pursuance of his researches he has visited India on four occasions (1870, 1876, 1880, 1886), extending his observations from Travancore to the Punjab, Assam and the loftiest Himalaya bordering on Tibet; the Eastern and Western United States, Canada, and Mexico (1888, 1893); Greece, Turkey, Asia Minor, and the Crimea (1869, 1874); Algeria (1882); and all parts of Europe. His collections and observations have yielded very important results, notably his paper "On the Geographical Distribution of Asiatic Birds" (*Proc. Zool. Soc.*, 1873), wherein the Himalayan and Chinese Avi-faunas are shown to be one. Other papers are: "On the Ornithology of the Cardamum Hills, Travancore" (*Ibis*, 1870); "On the Genus *Parnassius*" (*Proc. Zool. Soc.*, 1886); "On *Hemicurus*" (*Ibis*, 1872); "On the Papilionidæ of the Eastern Alps" (*Entom. Monthly Mag.*, 1880); and of "The Sikkim Himalaya" (*Proc. Zool. Soc.*, 1882); and of "Amur-land, N. China and Japan" (*loc. cit.*, 1881); and of the "Naga and Karen Hills" (*loc. cit.*, 1891–92). Mr. Elwes is author of a valuable memoir on the genus *Lilium*, and has, during his travels, communicated many interesting plants to the Royal Gardens, Kew.

JOHN SCOTT HALDANE,

M.D., M.A., M.R.C.P. (Edin.). Hon. M.A., Oxford. Lecturer in Physiology, University of Oxford. Author of the following and of other Memoirs:—"The Elimination of Aromatic Bodies in Fever" (*Journ. Physiol.*, vol. ix., 1888); "The Carbonic Acid, Organic Matter, and Micro-organisms in Air" (with Prof. Carnelley and Dr. Anderson), (*Phil. Trans.*, 1887); "The Air of Sewers" (with Prof. Carnelley), (*Proc. Roy. Soc.*, 1887); "The Air of Buildings and Sewers" (*Trans. Sanit. Inst.*, 1887); "The Accurate Determination of the Carbonic Acid and Moisture in Air" (with Mr. Pembrey), (*Phil. Mag.*, 1890); "A New Form of Apparatus for Measuring the Respiratory Exchange" (*Journ. Physiol.*, vol. xix., 1892); "The Physiological Effects of Air vitiated by Respiration" (with Mr. Lorrain Smith), (*Journ. of Pathol. and Bacteriol.*, 1892); "The Toxic Action of Expired Air" (with Mr. Smith), (*ibid.*, 1893); "An Improved Form of Animal Calorimeter" (with Drs. Hale White and Washbourn), (*Journ. Physiol.*, vol. xvi., 1894); "On Red Blood Corpuscles of Different Specific Oxygen Capacities" (with Mr. Smith), (*ibid.*, vol. xvi., 1894); "The Nature and Physiological Action of Black Damp" (*Proc. Roy. Soc.*, vol. lvii.); "Investigations on Composition, Occurrence, and Properties of Black Damp" (with Mr. W. N. Atkinson), (*Trans. Fed. Inst. Mining Eng.*, 1895); "The Relation of Carbonic Oxide to Oxygen Tension" (*Journ. Physiol.*, vol. xviii., 1889).

Supplementary Certificate.—Report to the Home Secretary on the Causes of Death in Colliery Explosions, 1896 (Parliamentary Paper); "The Nature and Sources of the Suffocation Gas met with in Wells" (*Trans. Fed. Inst. Mining Engineers*, vol. xi., p. 265); "Oxygen Fusion of Arterial Blood" (with Prof. Lorrain Smith), (*Journ. Physiol.*, in the Press).

WILLIAM A. HASWELL,

M.A., D.Sc. (Edin.). F.L.S. Vice-President Linnean Society of New South Wales. Trustee of the Australian Museum. Corr. Memb. Royal Society of Tasmania. Memb. K. Leopold.-Carol. Deutsche Akad., Halle. Challis Professor of Zoology, University of Sydney, N.S.W. Distinguished as a zoologist and comparative anatomist. Author of seventy-four papers, mainly morphological, including the following:—"Catalogue of the Australian Stalk and Sessile-eyed Crustacea," 1882; "On *Temnocephala*, an aberrant Monogenetic Trematode" (*Quart. Journ. Micros. Sci.*, 1888); "A Monograph of Temnocephaleæ" (Macleay Memorial Volume, 1892); "A Monograph of the Australian Aphroditeæ" (*Proc. Linn. Soc. N.S.W.*, 1882); "The Marine Annelides of the Order Serpulea" (*ibid.*, 1884); "On the Structure of the so-called Glandular Ventricle of Syllis" (*Quart. Journ. Micros. Sci.*, 1886); "On an apparently New Type of *Platyhelminthis*" (Macleay Memorial Volume, 1892); "A Revision of the Australian *Læmodipoda*" (*Proc. Linn. Soc. N.S.W.*, 1884); "A Revision of the Australian Isopoda" (*ibid.*); "Studies on the Elasmobranch Skeleton" (*ibid.*); "On the Structure of the Paired Fins of Ceratodus, &c." (*ibid.*, 1882); "Observations on the Early Stages in the Development of the Emu" (*ibid.*, 1887); "On Polycercus, a Proliferating Cistode Parasite of the Earthworms" (*ibid.*, 1893); "A Comparative Study of Striated Muscle" (*Quart. Journ. Micros. Sci.*, vol. xxx.), in conjunction with Mr. J. P. Hill.

GEORGE BOND HOWES,

F.L.S., F.Z.S., Assistant Professor of Zoology in the Royal College of Science, London. Member of Council of the Linnean Society, and of the Anatomical Society. Examiner in Zoology, Victoria University, and for the University of New Zealand. Author of an "Atlas of Elementary Biology," and joint co-author of the revised and extended edition of "Huxley and Martin's Practical Biology." Author of numerous papers on Morphology, dealing especially with the Ichthyopsida and Mammalia, of which the following are the more important:—"On some points in the Anatomy of the Porpoise" (*Journ. Anat. and Phys.*, vol. xiv. p. 467); "Notes on the Cranio-Facial

Skeleton of the Sturgeon" (incorporated in Prof. W. K. Parker's monograph in *Phil. Trans.*, 1882, p. 171); "The Morphology of the Mammalian Coracoid" (*Journ. Anat. and Phys.*, vol. xxi. p. 190); "On the Skeleton and Affinities of the Paired Fins of Ceratodus and those of the Elasmobranchii" (*Proc. Zool. Soc.*, 1887, p. 3); "On a hitherto Unrecognised Feature in the Larynx of the Anourous Amphibia" (*ibid.*, p. 491); "Rabbit with an Intra-Narial Epiglottis, with a suggestion concerning the Phylogeny of the Mammalian Respiratory Apparatus" (*Journ. Anat. and Phys.*, vol. xxiii. p. 263); "Additional Observations upon Intra-Narial Epiglottis" (*ibid.*, p. 587); "Variation in the Kidney of *Raia clavata*; its Nature, Range, and probable Significance" (*ibid.*, vol. xxiv. p. 407); "On the Visceral Anatomy of the Australia Torpedo" (*ibid.*, p. 669); "Observations on the Pectoral Fin-Skeleton of Living Batoid Fishes, and of the Extinct Genus Squaloraja," &c. (*ibid.*, p. 675); "On some Hermaphrodite Genitalia in *Gadus Morrhua*," &c. (*Journ. Linn. Soc. Zoology*, vol. xxiii. p. 539); "On the Probable Existence of a Jacobson's Organ among the Crocodilia; with Observations upon the Skeleton of that organ in the Mammalia," &c. (*Proc. Zool. Soc.*, 1891, p. 148); "Notes on the Shoulder-Girdle of certain Dicynodont Reptiles" (*ibid.*, vol. xxvi. p. 403); "On the Affinities, Intra-relationships, and Systematic Position of the Marsipobranchiata" *Trans. Liverpool Biol. Soc.*, vol. vi. p. 122), &c.

Supplementary Certificate.—Professor of Zoology, Royal College of Science, Treasurer Anatomical Society of Great Britain, and President of the Malacological Society of London; Zoological Secretary of the Linnean Society; Memb. Council Zoological Society. Has continued work on "The Morphology of Coracoid of Terrestrial Vertebrata" (*Proc. Zool. Soc.*, 1893, p. 385), and published papers dealing, among other subjects, with:—"Morphology of Pelvic Girdle of Mammalia" (*Journ. Anat. Phys.*, vol. xxvii. p. 543); "Variation and Development of the Vertebral and Limb-Skeleton of Amphibia" (*Proc. Zool. Soc.*, 1893, p. 268); Synostosis and Curvature of the Spine in Fishes" (*ibid.*, 1894, p. 95); "Types of Modification of Mammalian Hyoid" (*Journ. Anat. Phys*, vol. xxx. p. 513). Has edited and annotated English translation of Wiedersheim's "Bau des Menschen."

F. STANLEY KIPPING,

D.Sc. (Lond.), Ph.D. (Munich). Lecturer and Chief Assistant in the Chemical Department of the City and Guilds of London Institute, Central Technical College. Distinguished as an original and very skilful and persistent worker in Chemistry. Author of sixteen papers published in the *Transactions of the Chemical Society*, and of others in the *Journal of the German Chemical Society*, the following being the titles of several of these:—"The Synthetical Formation of Closed Carbon Chains in the Aromatic Series"; "Action of Phosphoric Anhydride on Fatty Acids" (3 parts); "Hydrindone and its Derivatives"; "Formation of the Hydrocarbon Truxene"; (in conjunction with Dr. Perkin) "Diacetylpentane and Dibenzoylpentane"; "Derivatives of Phenylhexamethylene"; "Synthesis of Dimethyldihydroxy hepamethylene," &c.; (in conjunction with Dr. Armstrong) "The Formation of Ketones from Camphor"; (in conjunction with Mr. Pope) "Sulphonic Derivatives of Camphor."

GEORGE BALLARD MATHEWS,

M.A., Professor of Mathematics in the University College of North Wales. Late Fellow of St. John's College, Cambridge; Fellow of University College, London. Eminent Mathematician. Author of the following works of merit in connection with Mathematics:—"Theory of Numbers" (1892); "Complex Multiplication Moduli of Elliptic Functions for the Determinants −53 and −61" (*Proc. Lond. Math. Soc.*, vol. xxi.); "On Class Invariants" (*ibid.*, vol. xxi.); "Note on Dirichlet's Formula for the Number of Classes of Binary Quadratic Forms for a Complex Determinant" (*ibid*, vol. xxiii.); "On Binary Quadratic Forms with Complex Coefficients" (*Quart. Journ. Math.*, vol. xxv.); "On the Classification of Symmetric Functions" (*ibid.*); "On the Expansion of the Coordinates of a Point upon a Tortuous Curve in terms of the Arc" (*ibid.*, vol. xxvi.); "Irregular Determinants and Sub-triplicate Forms" (*Mess. Math.*, vol. xx.); and others, a list of which is sent.

GEORGE ROBERT MILNE MURRAY,

F.L.S., F.R.S.E. Assistant (First Class), Department of Botany, British Museum. Naturalist to the Solar Eclipse Expedition to Grenada, 1886. Examiner in Botany, Glasgow University, 1887-92; Victoria University, 1889-92. Lecturer on Botany at the Royal Veterinary College, London. Author of numerous papers on the structure, classification, and distribution of Cryptogams, of which the following are the more important:—"Investigations into the Infection of Fishes with *Saprolegnia ferax*" (*Reports of the Inspector of Fisheries*, 1883-85); "On the Outer Peridium of *Broomeia*" (*Journ Linn. Soc.*, 1882); "On two New Species of *Lentinus*, one of them growing on a large Sclerotium" (*Journ. Linn. Soc.*, 1886); "On a New Species of *Rhipilia*" (*ibid.*); "On *Boodlea*, a New Genus of *Siphonocladaceæ*" (*Journ. Linn. Soc.*, 1890); The Distribution of Marine Algæ in Space and Time." (*Trans. Biol. Soc.*, Liverpool, 1891); "On a Fossil Alga belonging to the Genus *Caulerpa*, from the Oolite" (*Phycological Memoirs*, 1892); "On a New Species of *Caulerpa*, with Observations on the Position of the Genus" (*Trans. Linn. Soc.*, 1891); "On the Structure of *Dictyosphæria*" (*Phycological Memoirs*, 1892); "A Comparison of the Marine Floras of the warm Atlantic, the Cape of Good Hope, and the Indian Ocean" (*ibid.*); "On *Halicystis* and *Valonia*" (*ibid.*). Author of several articles in the "Encyclopædia Britannica," including "Fungi" and "Vegetable Parasitism." Joint author, with Mr. A. W. Bennett, M.A., of "A Handbook of Cryptogamic Botany," 1889; with Mr. Boodle, of Memoirs on "The Structure of *Spongocladia*" (*Annals of Botany*, 1888); "A Structural and Systematic Account of *Struvea*" (*ibid.*); "A Systematic and Structural Account of *Avrainvillæa*" *Journ. Bot.*, 1889); and, with Miss Barton, "The Structure and Systematic Position of *Chantransia*" (*Linn. Soc.*, 1891).

Supplementary Certificate.—Keeper of Botany, British Museum (Natural History). Author of "A Comparison of the Arctic and Antarctic Marine Floras" (with Miss Barton) (*Phycological Memoirs*, part iii.); "A New Part of Pachytheca" (*ibid.*); "On the Reproduction of some Marine Diatoms" (*Proc. Roy. Soc. Edin.*, 1897); "Introduction to the Study of Seaweeds," 1895.

FRANCIS HENRY NEVILLE,

M.A., College Lecturer. Fellow and Lecturer in Natural Science, Sidney College. Fifteenth Wrangler, 1871. Author of "Recent Progress in the Study of Alloys" (*Science Progress*, vol. iv. Nos. 20, 21); joint author with Mr. C. T. Heycock of the following:—"On a Simplified Form of Apparatus for Determining the Density of Ozone" (*Proc. Camb. Phil. Soc.*, vol. v.); "Lowering of the Freezing Point of Tin by the Addition of other Metals" (*Proc. Chem. Soc.*, No. 65, 1889); "Lowering of the Freezing Point of Sodium by the Addition of other Metals" (*Trans. Chem. Soc.*, vol. lv., 1889); "Molecular Weights of Metals when in Solution" (*ibid.*, vol. lvii.); "Freezing Point of Triple Alloys of Gold, Cadmium, and Tin" (*ibid.*, vol. lix.); "Lowering of the Freezing Points of Cadmium, Bismuth, and Lead, when alloyed with other Metals" (*ibid.*, vol. lxi.); "Isolation of a Compound of Gold and Cadmium" (*ibid.*); "Freezing Point of Alloys, in which Thallium is the Solvent" (*ibid.*, 1894); "Freezing Point of Triple Alloys" (*ibid.*); "On the Determination of High Temperatures by means of the Platinum Resistance Pyrometers" (*ibid.*, 1895).

H. ALLEYNE NICHOLSON,

M.D. (Edin.), D.Sc., Ph.D., F.G.S. Regius Professor of Natural History in the University of Aberdeen. Swiney Lecturer on Geology in the British Museum, 1877-81, 1890-94. Formerly Professor of Natural History in the University of Toronto, 1871-74; afterwards in the University of St. Andrews, 1875-82. Has devoted himself specially to the study of Palæontology. The following are the titles of some of the more important of his numerous published contributions:—"Manual of Palæontology" (third edition); "Invertebrata," 1889; "Monograph of the British Stromatoporoids)," 4to, 234 pp., 28 plates, 1885-92; "The British Graptolitidæ," 1872; "The Palæozoic Tabulate Corals," 1879; "On Monticulipora and its Subgenera," 1881; "Reports on Palæontology of the Province of Ontario," 1874-75; "Silurian Fossils of Girvan," 1881 (jointly with R. Etheridge, jun.); "Bibliography of N. American Invertebrate Palæontology" (with Prof. C. A. White), 1878; "Report on Silurian and Devonian Fossils of State of Ohio," 1875. He has also published numerous separate memoirs on the Graptolitidæ, the Stromatoporoids, the Palæozoic Corals, the Monticuliporoids, the Palæozoic Polyzoa, and certain obscure

organisms which contribute largely to form some palæozoic limestones. He has likewise contributed largely to our knowledge of the structure and fossils of the palæozoic rocks of the Lake District of the North of England by his "Essay on the Geology of Cumberland and Westmoreland," 1868; "On the Strata and their Fossil Contents between the Borrowdale Series and the Coniston Flags" (*Quart. Journ. Geol. Soc.*, 1867), jointly with Prof. Harkness; "Additional Observations on the Geology of the Lake District" (*ibid.*, 1866); "Relations between the Skiddaw Slates and the Green Slates and Porphyries of the Lake District" (*Geol. Mag.*, 1869); "On the Lower Portion of the Green Slates and Porphyries of the Lake District" (*Quart. Journ. Geol. Soc.*, 1871); "On the Occurrence of a New Fossiliferous Horizon in the Ordovician Rocks of the Lake District" (*Geol. Mag.*, 1888, conjointly with J. E. Marr); "On the Stockdale Series of the Lake District" (*Quart. Journ. Geol. Soc.*, 1888, conjointly with J. E. Marr); "On the Cross Fell Inlier" (*ibid.*, 1891, jointly with J. E. Marr). Prof. Nicholson was awarded the Lyell Medal by the Council of the Geological Society in 1888, "as a mark of appreciation of his valuable researches among the older palæozoic rocks, both in the Old and the New World, and of his continued and patient investigations into the organisation of some of those obscure forms of life which abounded at the period of the deposition of those rocks" . . . "his researches have given him a high place among Palæontologists," whilst as a teacher and lecturer he is most successful.

JOHN MILLAR THOMSON,

F.R.S.E., F.I.C. Secretary of the Chemical Society. Professor of Chemistry and Lecturer on Photography, King's College. Professor of Chemistry, Queen's College, London. Author of the following original papers:—"The Composition and Properties of Ancient Glass from Tombs in Cyprus" (*Proc. Phil. Soc.*, Glasgow, 1870); "The Composition of certain Double Salts of Nickel and Cobalt in their relation to Dichroism" (*Brit. Assoc. Rept.*, 1877); "Action of Isomorphous Salts on Supersaturated Solutions of other Salts" (*Journ. Chem. Soc.* 1879); "Action of Constituent Salts on Supersaturated Solutions of Double Salts and Mixtures" (*ibid.*, 1882). Author of the following published lectures and papers:—"The Position of Chemistry in a Technical Education" (*Journ. Soc. of Arts*, 1878); "Solution and Crystallisation" (Glasgow Science Lecture Association, 1879); "The Composition and Properties of certain Pigments" (Cantor Lectures, *Journ. Soc. of Arts*, 1885); "Suspended Crystallisation" (*Proc. Roy. Inst.*, 1886); "The Chemistry of Putrefaction and Antiseptics" (Cantor Lectures, *Journ. Soc. of Arts*, 1887). Distinguished as a lecturer and teacher in Chemistry.

FREDERICK THOMAS TROUTON,

Sc.D. (Dubl.), M.A. Assistant to Erasmus Smith's Professor of Natural Philosophy in the University of Dublin. Teacher of Experimental Physics. Discovered the law connecting the latent heat of vaporisation and molecular weights of bodies known as "Trouton's law" and experimentally determined the directions of vibration of electric and magnetic force in plane polarised light. He has made other important observations on the phase of secondary waves and on the influence of the size of the reflector in Hertz's experiment. Author of:—"On Molecular Latent Heat" (*Phil. Mag.*, vol. xviii.); "Repetition of Hertz's Experiments and Determination of the Direction of the Vibrations of Light" (NATURE, vol. xxxix.); "Experiments on Electromagnetic Radiation, including some on the Phase of Secondary Waves" (NATURE, vol. xl.); "Multiple Resonance obtained with Hertz's vibrations" (NATURE, vol. xli.); "On the Acceleration of Secondary Electromagnetic Waves" (*Phil. Mag.*, vol. xxix.); "The Influence of the Size of Reflector in Hertz's Experiment" (*Phil. Mag.*, vol. xxxii.); "Some Experiments to Determine Wave Velocity in certain Dielectrics" (*Rept. Brit. Assoc.*, 1890); "On Thermo-Electric Currents in Single Conductors" (*Proc. Roy. Dubl. Soc.*, 1886); "On Temporary Thermo-currents in Iron" (*Rept. Brit. Assoc.*, 1889); "On the Motion under Gravity of Fluid Bubbles through Vertical Columns of Liquid of a Different Density" (*Proc. Roy. Soc.*, vol. liv.); "On the Motion of a Body near Points of Unstable Equilibrium and on the same when capable of Internal Vibration" (*Proc. Roy. Dubl. Soc.*, 1888); "On a convenient Method of obtaining any required Electrical Potential for Use in Laboratory Teaching" (*ibid.*); "On the Control Supply Pipes have on Reeds" (*ibid.*); "A Coefficient of Abrasion as an Absolute Standard of Hardness" (*Rept. Brit. Assoc.*, 1880); "On the Use of a Permanently Magnetised Core in a Telephone" (*Phil. Mag.*, vol. xxxiv.); "On Ohm's Law in Electrolytes" (*Rept. Brit. Assoc.*, 1887–88), jointly with Prof. Fitzgerald; "A Method of Determining the Specific Induction Capacity of Dielectrics" (*Phil. Mag.*, vol. xxxiii.), jointly with Mr. W. E. Lilly.

HERBERT HALL TURNER,

M.A., B.Sc. Formerly Fellow of Trinity College, Cambridge. Savilian Professor of Astronomy, Oxford. Secretary to the Royal Astronomical Society. Late Chief Assistant at the Royal Observatory, Greenwich, 1884–94. Author of various papers, among which may be mentioned: "On the Correction of the Equilibrium Theory of Tides for the Continents" (with Prof. G. H. Darwin) (*Proc. Roy. Soc.*, vol. l.); "Report of Observations of the Total Solar Eclipse of August 29, 1886" (*Phil. Trans.*); "On Mr. Edgeworth's Method of Reducing Observations relating to Several Quantities (*Phil. Mag.*, vol. xxiv.); "On Mr. Marth's Intersects" (*Monthly Notices*, vol. xlvi.); "Observations for Coincidence of Collimator at Royal Observatory, Greenwich" (*ibid.*, vols. xlvi. and liii.); "On the Variations of Level and Azimuth of the Transit Circle at Royal Observatory, Greenwich" (*ibid.*, vol. xlvii.); "On the Longitude of Paris" (*ibid.*, vol. li.); "On Stellar Photography" (*ibid.*, vols. xlix. and lix.); "On the R.-D. Discordance" (*ibid.*, vols. liii., liv., and *Memoirs Roy. Astron. Soc.*, vol. li.); "On New Forms of Levels" (*Monthly Notices*, vol. lii.); "Comparison of the Cape (1880) and Greenwich (1880) Star Catalogues" (*Memoirs Roy. Astron. Soc.*, vol. li.); "On the Reduction of Measures of Photographic Plates" (*Monthly Notices*, vol. liv.).

EDWARD JAMES STONE, F.R.S.

THE distinguished astronomer, whose name stands at the head of this notice, and whose loss will be regretted in many scientific circles, played a very prominent part in the history of astronomy during the last forty years. Although he took an active, and often a foremost, place in all the astronomical problems that have aroused attention during this period, he was more conspicuously attached to the astronomy of position, and it was by his devotion to meridian observations that his reputation was mainly won. The early training which he received under Airy, at Greenwich, whither he went on leaving Cambridge in 1860, contributed to this choice. At that time the results obtainable by photography and spectroscopy were quite undeveloped, and the lines on which the Greenwich Observatory then worked were such as to ensure a devotion to accuracy, and the appreciation of the value of star catalogues. All who have since had occasion to use the star places which Mr. Stone published, whether from the Cape, or from the Radcliffe Observatory, have reason to be grateful for that training, which, resulting in his adherence to the methods that he early acquired, led to the production of such admirable work.

In connection with his meridian observations, Mr. Stone had, from time to time, published memoirs on the value of the constants of nutation and refraction, which, though they have not displaced the values assigned by other astronomers, have yet testified to his industry and illustrated his power of conducting a searching discussion into large masses of observations, possessing varying degrees of accuracy. He also largely identified himself with inquiries into the proper motions of stars, the systematic differences between stellar catalogues, the motion of the solar system in space—all questions which demand long numerical calculations, and the values of whose final results depend upon the maintenance of rigorous accuracy in the computations.

In striving to estimate the loss to science caused by the death of the Radcliffe Observer, we give prominence to his meridian work. We recognise the fact that the old

school of astronomy has lost an exponent whom it is not easy to replace. But it would be an injustice to his memory to forget that he showed at times considerable power of originality. His work on such questions as that of the Solar Parallax is deservedly well appreciated. Thirty years ago the problem of the sun's distance occupied a very different position to what it does now. Encke's value, obtained from the discussion of the Transits of Venus of 1761 and 1769, long used without question or hesitation, was beginning to lose its authority before the tests of more rigorous analysis, and the adoption of methods better suited for the determination of this fundamental constant. Stone, by his investigation of the observation of Mars in the opposition of 1862, contributed in no small measure to increase the suspicion which was hovering around the old value of 8″·58. With his attention drawn to this subject, he next reviewed the evidence on which this value was based. With better knowledge of the longitudes of the observing stations, and with possibly a more judicious interpretation of the observer's remarks, he was able to give not only greater accordance to the various observations, but to obtain a result more nearly equal to that derived from other sources of information. For this work he was awarded the gold medal of the Royal Astronomical Society, the President contending that Mr. Stone had shown, beyond all doubt, "that the method pursued by his illustrious countryman Halley, when fairly treated, is capable of furnishing a value of the Solar Parallax commensurate in precision with the expectations formed of it." The history of subsequent transits has, perhaps, not borne out this favourable view, expressed in 1869; but Stone's loyal and persistent efforts to deduce from the transits all that they were capable of giving are shown, by the part he took, both in 1874 and 1882. In the former year he was Her Majesty's astronomer at the Cape of Good Hope, and contributed much to the organisation of the various expeditions to the Southern Hemisphere. By the time of the second transit in 1882, he had succeeded to the direction of the Radcliffe Observatory on the death of the Rev. Robert Main, and there he trained the selected observers in methods suggested by the experience gained in 1874. After the transit, the whole of the observations were reduced under his immediate superintendence, with results too well known to need further mention.

It is needless to say that Mr. Stone's direction of the Radcliffe Observatory during the last twenty years was characterised with vigour and general success. Two important star catalogues were issued under his superintendence. The meteorological department received considerable attention, and Mr. Stone, in addition, accepted a seat at the Board of the Meteorological Council. In another matter, which one naturally wishes to pass over very briefly, his researches were not so successful, but have shown him the victim of a strange paradox. The comparatively large discrepancies which exist between the observed longitudes of the moon and those computed from Hansen's tables, he sought to explain by attributing their origin to the substitution of Le Verrier's tables of the sun for those of Carlini. This slight breach of continuity in the record of mean solar time, produced by the introduction of the newer tables into the Nautical Almanac was, he urged, the cause of the gradual increase in the error of Hansen's tables; and though many eminent authorities, including Profs. Adams and Newcomb, endeavoured to convince him of his error, he supported his views to the last, and regularly published the errors of the lunar tables, as derived from the Radcliffe observations, after applying to the mean time of observation a correction based upon his theory.

On two occasions Mr. Stone observed a total eclipse of the sun; the first at Klipfontein in Namaqualand, and last summer he accompanied Sir George Baden Powell to Nova Zemlya, where he was again successful in watching the phenomenon. But to the physical side of astronomy he gave little attention; nor is the Radcliffe Observatory equipped in a manner to make such observations possible.

Mr. Stone received many acknowledgments of the value of his work. Besides being a Fellow of the Royal Society, he had been President of the Royal Astronomical, and held other offices in connection with the same Society. He received a Doctor's degree from the University of Padua, and besides the Astronomical Society's medal, to which allusion has been made, the French Academy bestowed upon him the Lalande medal, as a testimony to the value of his Southern Catalogue of 12,500 stars. He died on Sunday, May 9, at his Oxford residence, aged sixty-six. W. E. P.

NOTES.

THE first of the two annual conversaziones of the Royal Society was held yesterday evening, as we went to press.

THE University of Toronto has decided to confer the degree of LL.D. upon Lord Lister, Lord Kelvin, Lord Rayleigh, and Sir John Evans.

THE fifteen candidates selected on Thursday last by the Council of the Royal Society to be recommended for election into the Society are:—Dr. R. Bell, Sir W. H. Broadbent, Bart., Dr. C. Chree, Mr. H. J. Elwes, Dr. J. S. Haldane, Prof. W. A. Haswell, Prof. G. B. Howes, Dr. F. S. Kipping, Prof. G. B. Mathews, Mr. G. R. Milne Murray, Mr. F. H. Neville, Dr. H. A. Nicholson, Prof. J. M. Thomson, Dr. F. T. Trouton, and Prof. H. H. Turner. Following our usual custom, we print in another part of this issue the certificates of the candidates selected.

DR. C. LE NEVE FOSTER has given men of science cause to be proud that he is one of them. On Saturday morning last he was at the Snaefell lead mine, Isle of Man, in his capacity of Her Majesty's Inspector of Mines. An explosion had occurred there on the preceding Monday, and Dr. Foster's object was to ascertain whether it was possible to recover the body of a miner remaining in the workings. Lighted candles sent down to test the atmosphere burnt brightly at 115 fathoms, but were extinguished at 130 fathoms. From these indications it was considered safe to go down a certain distance; so a party, consisting of Dr. Foster, Mr. G. J. Williams (Assistant Inspector of Mines), Captain Reddicliffe, Captain Kewley, and eight others descended the shaft. The air below was tested, and found to be poisonous; but as the party was only a few feet above the body of the miner, Captain Kewley went two or three steps down a ladder, and attempted to catch the man's clothing with grappling-irons. The commotion caused by his swinging to and fro appears to have disturbed the gas, for Captain Kewley was at once overcome, and had to be hauled back to the landing. He was put into the box, and the box was going up to the surface, when it became jammed, and for over an hour could not be moved. Meanwhile, Dr. Foster and those of his companions who could not climb to the surface were below suffering from the influence of the poisonous gas—apparently carbon monoxide. During this time, when death seemed to be very near, Dr. Foster made copious notes of his sensations. He commenced writing at 2 p.m., and continued until 3.30, when he was brought to the surface, he being the last to go up. Some of the men were unconscious when brought to the surface, and others arrived in an excited and hysterical condition. The record obtained by Dr. Foster will be a most valuable physiological document,

for, judging from the extracts given in the daily press, the gas to which the exploring party was subjected has a peculiar effect upon the mind. As the minutes passed by, Dr. Foster's notes became more and more disjointed, and it is hard to believe that he knew exactly what he was writing towards the end. The following are a few of the notes written while he believed himself to be dying:—"I fear we are all dying. No help coming. . . . The box does not come. In spite of all our ringing for help, it will not come. Captain Reddicliffe is struggling. No real pain. Good-bye. I feel as if I were sleeping. Again, good-bye all! 2.15 p.m.—We are all done. Oh, for the box! It is held in the shaft. . . . It is really like a bad dream. No pain. No pain. For the benefit of others, no pain. . . . 2.25 p.m.—Two of the party are all right. I think they are ringing. When is help coming? The box is gone. Four new men are coming. I don't feel bad. It is strange to write notes while we are dying. What a lot I have written! Captain Reddicliffe is about the worst. I think he will go first. While there is life there is hope. Good old proverb! Send a note for more brandy. Send for more help. The box has just gone up with Reddicliffe. Williams goes next—he has a capital heart. 2.45.—I have written pages. Kewley is a good fellow. There is life in the old horse yet. I feel as if I could sing. God is helping us; he has heard our prayer. My turn to go." Arriving at the surface, and getting out of the box, Dr. Foster, note-book in hand, though weak and staggering, made the entry stating the time at which he got to the top. His last entry was:—"Dr. Miller says I must be quiet, but I won't." The pathetic side of this record, made by one who had almost crossed the dark valley, but was happily brought back to tell his tale, touches all of us. We admire Dr. Foster for his coolness in time of danger, and for remaining behind until all his party had been rescued. The world could ill spare a man with such sterling qualities, and science would grieve to lose an investigator who devoted what seemed to be his last moments to extending knowledge "for the benefit of others." We offer to Dr. Foster our heartiest congratulations upon his rescue, and we trust that he may never again have to repeat his terrible experience.

THE next annual meeting of the Australasian Association for the Advancement of Science will commence on January 6, 1898.

M. SOUILLART, Professor of Astronomy in the University of Lille, has been elected a Correspondant in the Section d'Astronomie of the Paris Academy of Sciences, in succession to the late Prof. Gyldén.

A REUTER correspondent at St. Petersburg states, on the authority of the *Novoe Vremya*, that an expedition is to be sent by the Russian Geographical Society and Academy of Sciences to study the geography and natural history of the Khanates of Roshan, Shignan, and Darwaz.

WE learn from *Science* that Miss Alice Bache Gould has given $20,000 to the National Academy of Sciences as a memorial to her father, the distinguished astronomer, Dr. B. A. Gould. It will be known as the Gould Fund, and the income will be used to promote researches in mathematics and astronomy.

A COMPLIMENTARY banquet will be given to Lord Lister at the Café Royal, Regent Street, on May 26, by his former house-surgeons, clerks, and dressers. A complete list is being prepared of those who have been closely associated with Lord Lister in his teaching career, which extends over a period of thirty-two years—from 1861 to 1893.

THE vehicles entered for the *Engineer* 1100 guineas road carriage competition will be examined by the judges on Friday and Saturday, May 28 and 29, at the Crystal Palace. The long-distance run, between the Crystal Palace and Post Office in Birmingham, will begin on Tuesday, June 1. The distance over the whole course, upon which the time allowance referred to in the conditions will be computed, has been fixed by the judges at 263 miles.

THE Prussian Academy of Sciences have made a grant of 1100 marks to Prof. Dr. Paschen, Hanover, for the study of the energy in the spectra of dark bodies; and of 1000 marks to Dr. N. Herz, now at Heidelberg, for the reduction of observations made at the Kuffner Observatory, Vienna. Dr. O. Bütschli, Heidelberg, and Dr. A. Weismann, Freiburg, have been elected corresponding members of the Academy.

THE Engineering Conference, organised by the Institution of Civil Engineers, will be opened at 10.30 a.m. on Tuesday, May 25, in the large hall of the Westminster Town Hall, when the President, Mr. J. Wolfe Barry, C.B., F.R.S., will deliver a short address to the combined Sections. The several Sections will then proceed to the consideration of their respective business in the Town Hall and the Guildhall. The meetings will be continued on the 26th and 27th, at the same places, at 10.30 each day.

MR. ROBERT C. L. PERKINS, B.A. of Jesus College, Oxford, who has been for several years engaged on behalf of the Joint Committee appointed by the Royal Society and the British Association for investigating the zoology of the Sandwich Islands, has now returned to England, and, we rejoice to say, is in good health, notwithstanding all the hardships he has undergone. A very instructive paper by him, on "The Introduction of Beneficial Insects into the Hawaiian Islands," will be found in NATURE of March 25 last (p. 499).

THE summer meeting of the Anatomical Society of Great Britain and Ireland will be held this year in Dublin, on June 9, 10, and 11. A very large number of members have promised to attend, and the meeting will be remarkable on account of the numerous distinguished continental anatomists who are expected to take part in the proceedings. Amongst these are Prof. His, Leipzig; Prof. Waldeyer, Berlin; Prof. Stieda, Königsberg; Prof. Spalteholtz, Leipzig; Prof. Disse, Marburg; Prof. Klaatsch, Heidelberg; Dr. Otis, Boston; Prof. Leboucq, Ghent; Prof. van der Stricht, Ghent; Prof. van Gehuchten, Louvain; Prof. Retzius, Stockholm; Dr. Kaestner, Leipzig; Dr. de Bruyne, Ghent; and Dr. Fröhse, Berlin. One of the features of the meeting will be an address to be delivered by Prof. His in the new theatre of the Royal Dublin Society, under the auspices of the Royal Academy of Medicine in Ireland. The subject which he has chosen for this address is the "Development of the Brain, Cord and their Nerves." The ordinary meetings of the Society will be held in the Anatomy School of Trinity College.

MR. LAWRENCE BRUNER, of the University of Nebraska, has (says the *American Naturalist*) sailed to Argentina to study the ravages of the locusts, which have recently developed into a terrible pest, certain regions being completely devastated by them. The Argentine Government has granted 400,000 dols. for relief, and a syndicate of business men have raised funds to employ Mr. Bruner to investigate the entomological aspects of the subject.

WE regret to have to include in this week's obituary the names of Prof. Legrand des Cloizeaux, member of the Paris Academy of Sciences, and distinguished for his works on crystallography and the optical properties of minerals; Dr.

H. V. Carter, for many years professor of anatomy and physiology in the Grant Medical College at Bombay; Mr. Walter Rivington, author of a large number of papers on anatomical and surgical subjects, and Fellow of the University of London; Dr. Traill Green, formerly professor of chemistry at Lafayette College; Dr. E. Russow, formerly professor of botany at Dorpat; Dr. Ch. Scholz, professor of geodesy in the Polytechnikum at Delft; and Dr. Traill Green, one of the few surviving founders of the American Association for the Advancement of Science, first president of the American Academy of Medicine, and author of the "Floral and Zoological Distribution of the United States."

AT the Royal Institution, on Tuesday, May 25, Dr. Ernest H. Starling will begin a course of three lectures on "The Heart and its Work." The evening discourse on Friday, May 21, will be delivered by Lord Kelvin, his subject being "Contact Electricity of Metals." The Friday evening discourse next week (May 28), will be delivered by Prof. H. Moissan (Directeur, Laboratoire de Chimie Minérale à l'École Supérieure de Pharmacie, Membre de l'Académie des Sciences, Paris), who will lecture in French on "The Isolation of Fluorine" (with experiments). On Friday, June 4, Mr. W. H. Preece, C.B., F.R.S., will lecture on "Signalling through Space without Wires"; and on June 11, Mr. William Crookes, F.R.S., will deliver the last of the Friday evening discourses for the year: his subject will be "Diamonds."

THE Board of Agriculture have issued an order which prohibits the importation of dogs into Great Britain from any other country (except Ireland and the Isle of Man) otherwise than in accordance with certain provisions set forth. The order takes effect on September 15, 1897. After that date no dog may be landed in Great Britain from any other country without a licence from the Board of Agriculture, application for which is to be made to the Secretary of the Board. We agree with the *British Medical Journal* that this action of the President of the Board of Agriculture must be regarded as a step in the right direction. Any scheme for the extermination of rabies and its dependent hydrophobia which does not deal with importation of dogs must be incomplete. It is pointed out, however, that if simultaneous action as to the enforcement of muzzling and importation regulations be not taken in Ireland, it is to be feared that the present attempt to exterminate rabies from Great Britain may fail. A general muzzling order and the present importation order should now be made applicable to Great Britain and Ireland; for, without further assurance of freedom from rabies than can now be given, it cannot be regarded as absolutely safe to introduce without restriction dogs from one part of the United Kingdom to another.

THE provisions of the new Dingley Tariff Bill, taxing books, apparatus, and antiquities imported into the United States, raised such a storm of protests from scientific men and institutions of learning, that they appear to have been abandoned; for we learn from *Science* that the Tariff Bill, as amended by the Senate Finance Committee, includes the following additions, among others, to the list of objects which may be imported free of duty: books, maps, music, engravings, photographs, etchings and charts, printed more than twenty years before the date of importation; all hydrographic charts and scientific books devoted to original scientific research, and publications issued for their subscribers by scientific and literary associations, or publications of individuals for gratuitous private circulation, and public documents issued by foreign Governments; books, maps, &c., especially imported, not more than two copies in any one invoice, for the use of any society or institution established solely for religious, philosophical, educational, scientific or literary purposes, or for the encouragement of the fine arts, or for the use of any college, school or public library, and not for sale; paraffin, philosophical and scientific apparatus for schools, libraries and societies; professional books, implements and instruments, and tools of trade or occupation in the actual possession at the time of persons arriving in the United States.

AT the Leathersellers' Hall on Wednesday, May 12, a large company assembled at a conversazione; the Master, Dr. W. H. Perkin, F.R.S., and Wardens receiving the guests. The numerous and varied nature of the exhibits added great interest to the occasion; and not only were scientific discoveries, mostly of recent date, shown, but the industry associated with the name of the Company was well illustrated. Several very interesting objects were also sent from the different branches of the City and Guilds Institute, a creation of the City Companies of which they may well be proud. The following is a brief summary of the exhibits:—Specimens illustrative of the manufacture of coal-tar colouring matters, and their application, Dr. W. H. Perkin. Among Prof. Ayrton's exhibits may be mentioned an ingenious water model illustrating the retardation of signals in a submarine telegraph cable, a mechanical model illustrating the principle of duplex telegraphy, and some instruments employing the magnifying spring devised by Profs. Ayrton and Perry. Prof. Roberts-Austen exhibited an electric furnace in operation, throwing an image of the interior on a screen. A most interesting collection of specimens of artistic bookbindings was exhibited by Mr. H. B. Wheatley. Photography in colours, and various processes of photographic reproduction were largely represented. Sir H. T. Wood exhibited illustrations of the Dansac-Chassagne process of colour photography. The Autotype Company showed various pictures reproduced by their process, and Mr. Ives gave lantern demonstrations of the Kromskop. Other exhibits included specimens from the Leathersellers' tanning and dyeing school; maps, diagrams, &c., made by the boys in Colfe's school, which is under the management of the Company; specimens in illustration of research work now in progress in the chemical department of the Central Technical College, and several others too numerous to mention in this brief summary.

TWO young oak-trees were planted on May 11, at Cowthorpe, near Wetherby, to commemorate the celebrated tree which stands there still, but is greatly decayed, and may not endure much longer. The old tree, as every one knows, girths more than fifty feet, and is in that respect probably the largest oak in the world. The young oaks have been raised from acorns taken from the old tree by Mr. John Clayton, of Bradford, in 1893. The late Mr. Montagu, of Ingmanthorpe, approved of this method of perpetuating the memory of the wonderful tree.

PROF. JOHN MILNE, F.R.S., has sent us a list of ninety-three earthquakes observed by him at Shide, Isle of Wight, from June 14, 1896, to March 1897. The Greenwich mean time of each disturbance is given, and the character and intensity of each record is stated.

IN the *Annales de la Société Belge de Microscopie*, M. A. Lemeere records the results of an experiment in establishing a "peripatetic laboratory" for the zoological and botanical students of the University of Brussels during the summer vacation.

WE learn from the *American Naturalist* that President Cleveland had, by proclamation, set apart thirteen new forest reserves in the United States, representing an area of more than 21 million acres. This increases the total reserve forest land in the West to 39 million acres. The new reserves include all the central portion of the Black Hills of South Dakota, the Big Horn Mountain Range in Wyoming, the Jackson Lake country south of the National Park in Wyoming, all the Rocky Mountains of Northern Montana, a valuable forest region in Northern

Idaho, the principal part of the Bitter Rest Mountain region in Montana and Idaho, the Cascade Mountains of the Yosemite National Park, the San Jacinto Mountains in Southern California, and the Uintah Mountains in Northern Utah. The selection of these forest lands was made by the Commission appointed by the National Academy of Sciences. Strong opposition has been made to the appropriation by private owners.

"THE FLORENTINE CRICKETS" is the title of an interesting essay in the folk-lore of these insects, by Sophia Beale, in *The Reliquary and Illustrated Archæologist* (vol. iii., 1897, p. 65). In Florence, at the Festival of the Ascension, "all the inhabitants prance about carrying little cages dangling from their fingers. It is an ancient custom, its origin is as vague as the date of its institution, but all agree that the little beasts, which are imprisoned in the cages, are a species of talisman—an omen for good or evil to the person who possesses them."

THE re arrangement of the Free Public Museums of Liverpool is rapidly progressing under the administration of Dr. H O. Forbes. He recognises that Anthropology, or rather that portion of it which is now sometimes termed Anthropography, is a branch of Biology, and so he has devoted a gallery to an exposition of the main races of men at the end of the series of galleries allocated to the Vertebrates. The collection forms an instructive introduction to Ethnology, and we hope that he will be able to make it more complete as opportunities present themselves. The Ethnographical collections, which are in another part of the building, are well displayed, and contain many interesting objects. These collections, together with the well-known Archæological treasures in the Museums, afford a good foundation for Anthropological studies in Liverpool.

THE *Records* of the Geological Survey of India (vol. xxx. part 1) contain the full account of a palæo-botanical discovery which has been made independently and simultaneously in India and in South Africa. The fossil plant-structure long known under the name of *Vertebraria* is now shown to be nothing else than the rhizome of the fern *Glossopteris*, which has given its name to the remarkable flora of the Gondwana-beds of the southern hemisphere. The specimens figured by Mr. R. D. Oldham show the association of leaf and rhizome clearly, as also do those described by M. Zeiller from near Johannesburg.

M. ÉMILE MÜLLER, Professor in the Lycée of Tashkent, sends to the Société de Géographie an extract from an account of an expedition on the Pamirs by Messrs. Olifsen and Filipsen, Danish officers, describing a remarkable tribe of dwarfs discovered in a little-known part of this region. The men of this tribe are invariably of exceedingly small stature, and a similar dwarfish habit extends to the domestic animals; the oxen of this district are about the size of donkeys, donkeys are no bigger than dogs, while goats and sheep are mere miniatures. In the original account published in the Russian journal, *Pravitelstvenni Viestnik*, for January 11/23, the explorers ascribed these anomalies to the exceptional environment and the arrested development due to the great scarcity of food. The tribe in question is entirely savage, badly armed, and wholly occupied in hunting; their religion is a species of fire-worship.

AMONG recent papers dealing with optical theories in general, we would call attention to Herr Paul Glan's interesting series of theoretical investigations on elastic bodies and light, in *Wiedemann's Annalen*, where results are found agreeing remarkably well with those obtained by experiment with Röntgen and ultra-violet rays; to a short paper in the *Berliner Sitzungsberichte*, by Prof. H. Rubens and E. F. Nichols, on the observation of electric resonance in heat rays of great wave-length; to a lengthy memoir, by Prof. G. Quesneville, on the double elliptic refraction of quartz (Paris, Offices of the *Moniteur Scientifique*, 1896), in which the author criticises MacCullagh's theory; and to Prof. Augusto Righi's two papers in the *Atti dei Lincei*, vi. 6—one on the elliptic polarisation of electromagnetic waves and their ellipsoid of polarisation in selenite, the other dealing with the absorption of electro-magnetic waves.

PROF. G. O. SARS, who has for many years been specially engaged in the study of the various groups of Crustacea, has in preparation a complete account of the Crustacea of Norway, and his work is now in course of publication by the Bergen Museum. All the known Norwegian species will be described, and will be accompanied by carefully drawn figures of all the forms. Parts iii. and iv. of vol. i., containing descriptions and illustrations of members of five families of Isopods, viz. Anthuridæ, Gnathiidæ, Ægidæ, Cirolanidæ, and Limnoriidæ, have just been issued.

SOMEWHAT late in the season we have received from Mr. Murray a new edition of his "Handbook for Travellers in Lower and Upper Egypt," which has been practically re-written and edited by Miss Brodrick, Prof. Sayce, and Captain Lyons, R.E. It has long been known that the late Sir G. Wilkinson's "Guide" was antiquated, and many of his views and conclusions have for some time past been shown to be untrustworthy, notwithstanding their excellence forty or fifty years ago. Mr. Murray's new work is well printed on thin paper, and takes up less room than the earlier editions; we venture to think that a "Guide" in one volume is always more useful than one in two. We welcome the new maps with which the book is furnished, and every one who takes any interest in hieroglyphics will rejoice that the old wood-blocks of the cartouches of the kings' prænomens and nomens have been replaced by legible hieroglyphic type. A special feature of the book is the Arabic Vocabulary; and although it is hard to understand on what principle the words have been selected, it will, no doubt, be useful to the intelligent visitor to Egypt.

MESSRS. GEORGE HOUGHTON & SON, photographic manufacturers and dealers, have just published a comprehensive illustrated catalogue of photographic apparatus and materials.

MANY chemists have at various times expressed the view that the acid amides, such as acetamide and benzamide, have not the constitution which is usually assigned to them, $NH_2 . R = O$, but are in reality hydroxy-derivatives of the formula $NH = R . OH$. An important contribution to this subject is made in the current number of the *Berichte* by W. Eschweiler, who has succeeded in preparing a new isomeride of glycollamide, $CH_2(OH) . C\left\langle\begin{matrix} O \\ NH_2 \end{matrix}\right.$, which differs entirely in properties from that compound, and appears to be the hydroxy-compound $CH_2(OH) . C\left\langle\begin{matrix} OH \\ NH \end{matrix}\right.$. The new compound is obtained by heating the corresponding nitrile, $CH_2(OH) . CN$, with water to a high temperature, and, like glycollamide, is converted into glycollic acid by the action of alkalis. The author has obtained similar isomerides of a number of other acid amides, the full description of which will be awaited with interest.

THE current number of the *Zeitschrift für Physikalische Chemie* contains a paper, by Prof. Ostwald, on the crystallisation of super-saturated solutions and of super-cooled liquids, which adds considerably to our knowledge of this little-studied subject. The chief difficulty of the experiments is caused by accidental infection of the solutions by particles of solid dust. This may be avoided by a proper choice of substances, and it may then be

proved that crystallisation is only caused by the introduction of a crystal of the substance, or of a strictly isomorphous substance. For example, fused salol (melting point 39°·5) cannot, at ordinary temperatures, be induced to crystallise by any of the usual means; but if a fine thread of glass be lightly drawn over a crystal of salol, it acquires the power of inducing crystallisation in the liquid; it loses it again by exposure to the air for a few minutes, by wiping with soft sheet india rubber, or by warming above 40°. There is, however, only a limited range of temperature below the melting point in which spontaneous generation of crystals is impossible; the liquid is here in stable equilibrium, except with respect to a ready-formed crystal. Ostwald proposes the name *metastable* for this condition. At still lower temperatures, crystals form spontaneously and without the presence of ready-formed nuclei; the equilibrium is here really labile. The analogy between the phenomena observed during the passage from the liquid to the solid condition, and those observed in the passage from gas to liquid, is pointed out. Notwithstanding the very minute quantity of substance required to start the crystallisation, Prof. Ostwald has succeeded in showing that it has a lower limit. The two methods employed (successive dilution with an indifferent solid substance in the way practised by the homœopathists, or evaporation of minute drops of successively more and more dilute solutions of the solid on a platinum wire, and introduction of the residues into the supersaturated liquid) gave practically identical results. With sodium chlorate solution, for example, containing 107 parts of the salt to 100 of water, the smallest quantity of solid, which would still induce crystallisation, was from a millionth to a ten-millionth of a milligram. The fact that a very minute quantity of ammonia alum induces crystallisation of a solution of potassium alum, instead of being itself dissolved, may be explained by supposing that the dissolved salt diffuses into the solid particle as soon as it comes in contact with the solution; a nucleus of the solid potassium alum having been thus formed, it continues to increase. This explanation is in agreement with the facts that only truly isomorphous salts are capable of forming solid solutions, and also that they alone are capable of mutually inducing crystallisation. For the statement and discussion of a proposition, which may be paraphrased as follows, the paper must be consulted. When a system passes from any given condition to a more stable one, it will not pass into the state which, under the circumstances, is the most stable, but into that which is nearest to the original state.

THE additions to the Zoological Society's Gardens during the past week include a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Sir Henry A. Blake, K.C.M.G.; a Pig-tailed Monkey (*Macacus nemestrinus*) from India, presented by Mr. W. B. Orme; an Egyptian Jerboa (*Dipus ægyptius*) from Egypt, presented by Mr. S. Whitehouse; a Kinkajou (*Cercoleptes caudivolvulus*), a Sharp-nosed Crocodile (*Crocodilus acutus*) from Venezuela, a Rough-eyed Cayman (*Caiman sclerops*), two Tuberculated Iguanas (*Iguana tuberculata*), a Black-pointed Teguexin (*Tupinambis nigropunctatus*), a Chequered Elaps (*Elaps lemniscotus*), an Anaconda (*Eunectes murinus*) from Trinidad, two —— Geckos (*Thecadactylus rapicauda*), a Cuvier's Scolecosaurus (*Scolecosaurus cuvieri*), an Agile Lizard (*Mabuina agilis*), three Thick-necked Tree Boas (*Epicrates ceuchris*), four Common Boas (*Boa constrictor*), five Cooke's Tree Boas (*Corallus cookii*), a Mocassin Snake (*Tropidonotus fasciatus*), a Boddaert's Snake (*Drymobius boddaerti*), a —— Snake (*Coronella calligaster*), a —— Snake (*Helicops angulatus*) from the West Indies, presented by Mr. R. R. Mole; an Anaconda (*Eunectes murinus*) from Trinidad, presented by Mr. F. W. Urich; an Indian Pigmy Goose (*Nettopus coromandelianus*) from India, a Laughing Kingfisher (*Dacelo gigantea*) from Australia, a Temminck's Snapper (*Macroclemmys temmincki*) from the Southern United States, deposited; six Mexican Quails (*Callipepla squamata*) from Mexico, purchased; two Egyptian Weasels (*Mustela subpalmata*), eight Shaw's Gerbilles (*Gerbillus shawi*), an Egyptian Jerboa (*Dipus ægyptius*), three Long-eared Hedgehogs (*Erinaceus auritus*), a Grey Monitor (*Varanus griseus*), nine Egyptian Cobras (*Naia haje*), eight Cerastes Vipers (*Cerastes cornutus*), a Rough-keeled Snake (*Dasypeltis scabra*), three Clifford's Snakes (*Zamenis diadema*), two Hissing Sand Snakes (*Psammophis sibilans*), ten Ocellated Sand Skinks (*Seps ocellatus*), four Vinaceous Turtle Doves (*Turtur vinaceus*), two Lesser Pin-tailed Sand Grouse (*Pterocles exustus*) from Egypt, received in exchange.

OUR ASTRONOMICAL COLUMN.

RESOLVING POWER OF TELESCOPES AND SPECTROSCOPES.—In the current number of the *Memorie della Società Degli Spettroscopisti Italiani* (vol. xxvi., 1897), Prof. F. L. C. Wadsworth discusses the question of the theoretical resolving power of optical instruments, distinguishing between four different cases. According to Rayleigh, the theoretical angular resolving power of any instrument having an aperture of width b is

$$a = m\frac{\lambda}{b}$$

where a is the angle between two fine lines or points which can just be separated (a close double, for instance): λ the mean wave-length of the light employed, b the linear aperture of the instrument, and m a constanr, varying according as the aperture is rectangular or circular. The spectral resolution of separation of a spectroscope can be determined from this formula by considering the dispersing train of prisms or gratings as a series of spectral images of the slit of the spectroscope. The four cases which are minutely dealt with are: (1) The resolving power (theoretical) of a spectroscope train for an infinitely narrow slit and monochromatic radiations, *i.e.* infinitely narrow spectral lines. (2) The resolving power (also theoretical) for a wide slit and monochromatic radiations. (3) The resolving power (limiting) for an infinitely narrow slit, but for lines of finite width $\Delta\lambda$. (4) The resolving power (practical) for a wide slit and non-monochromatic radiations, ranging for each line over a small value of $\Delta\lambda$, as in (3). This quantity represents the practical resolving power or purity of the spectrum.

The expression for the spectroscopic resolution for the second case differs from that obtained in the first by the presence of a new factor in the denominator of the former. The existence of this necessitates, as Prof. Wadsworth says, a considerable modification of certain statements based on the old formula of purity. Instead of a continual decrease with increase of slit width, the purity of the spectrum actually increases up to a certain point, and is equal to the theoretical resolving power of the instrument. On a further widening of the slit, the purity begins to diminish, but not so rapidly as previously supposed. This modification of the old idea requires, as he points out, a correction in Schuster's remarks on the practical purity of a bright-line spectrum, which gives the purity as 50 per cent. of the resolving power, and not 75 per cent., as Prof. Wadsworth now finds it must be. Other points of equal interest result from this new discussion, and are dealt with in this paper.

PHOTOGRAPHS OF METALLIC SPECTRA.—An investigation of considerable utility in astrophysics (*Sitzungsberichte der König, Preuss, Akad. d Wiss. zu Berlin*, March 4, 1897) has recently been concluded by Dr. O. Lohse in Potsdam. This consists in the determination of the wave-lengths of the lines in the spectra of cerium, lanthanum, didymium, thorium, yttrium, zirkonium, vanadium, and uranium, for the violet region 400 $\mu\mu$ to 460 $\mu\mu$. The spectra were obtained by photography with a spectroscope fitted with a prism filled with zimmtaethyl, the length of the resulting spectrum between the above wave-lengths measuring 180 mm. Spark spectra alone were investigated, and by means of a gas motor and dynamo a considerable strength of current was obtained. During the experiments it was found that the heat affected to an appreciable extent the refractive and dispersive power of the fluid in the prism, although it was not sufficient to be measurable with delicate thermometric instruments. The definition of the lines was therefore to

some extent not very good; for the same reason, exposures longer than 70 seconds were not deemed advisable. These temperature variations made the measurements of wave-length a more difficult task than would have been the case had they been absent, but Dr. O. Lohse seems to have taken the greatest pains to overcome this point; the measures were based on the solar spectrum, Rowland's normal lines being adopted; while the spectrum of iron was used as a comparison. It is stated that the measures may be generally taken as accurate up to a tenth of an Angström unit (0·01 $\mu\mu$), and only in the cases of very dim or broad lines is this limit exceeded; the intensities are given on a scale of tenths. The communication concludes with tables of the wave-lengths thus obtained.

THE ROYAL GEOGRAPHICAL SOCIETY.

AT the anniversary meeting of the Royal Geographical Society, on May 17, the President, Sir Clements Markham, F.R.S., in place of the usual annual address, gave a review of the progress of British geography during the sixty years of the Queen's reign. The practice of delivering an anniversary address was commenced in 1837 by the then President, Mr. W. R. Hamilton, in the eighth year of the Society. The first presidential address took the form of a survey of the position of geography at the time, and now forms a suitable landmark by which to estimate the advance that has been made. The Ordnance Survey of the British Islands was fairly under way, and that of India was also in progress. Hydrographic surveys were being pursued by British ships in every sea, and the coasts of Africa had been charted. The whole interior of Africa, most of Australia, and immense territories in Asia and South America were absolutely unexplored. The whole science of oceanography, although created by Rennell, had not yet been recognised.

One of the first pieces of geographical research of the Queen's reign was the memorable voyage of Sir James Clark Ross to the antarctic regions in 1839-41, and this may be held to be the only antarctic expedition ever sent out. Of late years the necessity for an antarctic expedition has become more and more urgent, for many reasons, but chiefly because the science of terrestrial magnetism is at a standstill, owing to the absence of any observations in the far south during the last fifty years. The knowledge which would be acquired by such a magnetic survey will not only be of scientific interest, but will also be of practical importance to navigation. Deep-sea soundings, dredgings, temperatures of the ocean at various depths, meteorology, the distribution of marine organisms, are some of the investigations which would be undertaken by an antarctic expedition with reference to the ocean. Equally important objects would be to determine the extent of the south polar land, to ascertain the nature of its glaciation, to observe the character of the underlying rocks and their fossils, and to take meteorological observations on shore.

Since 1893 the most strenuous efforts have been made to induce the Government to send out another naval antarctic expedition, but without result. We have been told that officers cannot be spared from the ordinary routine of the fleet; that times are much changed from the days of the *Challenger's* commission, and are now much more unsettled. It is forgotten that the naval superiority of Great Britain, in the days of St. Vincent and Trafalgar, "lay not in the number of her ships, but in the wisdom, energy, and tenacity of her officers and seamen," and that these qualities are now to be acquired by such special service as is involved in an antarctic expedition. It is forgotten that in the good old times neither war nor the fear of war were any check to the despatch of naval expeditions of discovery. Captain Cook was sent on his third voyage at a time when France, Spain, Holland, and the American insurgents were all vainly banded together for our destruction. In the midst of the French revolutionary war, Captain Vancouver was calmly surveying the intricate straits and sounds of New Albion, and Captain Flinders was exploring the shores of Australia.

The duty which will not be undertaken by the Government, will now receive the special attention of the Society, which will not appeal in vain for co-operation to the patriotism and energy of private individuals in Great Britain, or to the Governments in Australasia.

In the arctic regions Englishmen have discovered the whole of the American side from Bering Strait to the north coast of Greenland, and have explored the intricate system of channels and straits which separate the numerous islands. They have thus thrown open to the knowledge of the world a vast amount of information in all branches of science, and have especially taken the largest share in preparing for the solution of the polar problem. Dr. Nansen, by his memorable drift of the *Fram*, has supplied what was needed to complete the means of comprehending what had previously been a mystery. For this great service to geography Nansen has received a special gold medal from the Society; and he has rendered ever memorable, in arctic history, the sixtieth year of the Queen's reign. It saw the solution of the north polar problem.

The main points in the history of the exploration of each continent were touched upon, and the part taken by the Society in the work made plain, the President summing up the results as follows.

"When we contemplate these immediate consequences of our geographical work, it will, I am sure, be felt by all who are connected with this great Society, that it occupies a position of national importance, a position which entails most serious duties and heavy responsibilities. It is our privilege to render frequent services to several departments of the Queen's Government; to take the lead in numerous enterprises, many of which are eventually recognised, in their results, as involving considerable benefits to the nation; and to prepare the means, by our great collections of books and maps, and by the facilities we can give for instruction, for others, including the authorities under Imperial guidance, to follow in our footsteps."

As regards the new departures in the work of the Royal Geographical Society, the President mentioned the institution of a diploma for proficiency in practical astronomy and surveying, and the according of a large measure of support to Mr. Mackinder's scheme of a London School of Geography.

The Royal medal awarded to Dr. G. M. Dawson was handed to Sir Donald Smith, the High Commissioner for Canada; that awarded to M. P. P. Semenoff was given to M. Lessar, of the Russian Embassy. The Danish Minister received the awards given to Dr. Thoroddsen and Commander Ryder, while Lieutenant Seymour Vandeleur received the Murchison grant in person.

THE IRON AND STEEL INSTITUTE.

THE annual spring meeting of the Iron and Steel Institute was held on Tuesday and Wednesday of last week, in the theatre of the Institution of Civil Engineers. There were twelve papers down on the list, as follows:—"On the Permeability of Steel-making Crucibles," by Prof. J. O. Arnold and F. K. Knowles; "On the Practice of the Combined Open-Hearth Process of Bertrand and Thiel," by E. Bertrand; "On the Agricultural Value of Sulphate of Ammonia from Blast-Furnaces," by F. J. R. Carulla; "On the Specific Heat of Iron," by Prof. W. N. Hartley, F.R.S.; "On Charging Open-Hearth Furnaces by Machinery," by Jeremiah Head; "On the 'Weardale' Reheating Furnace," by H. W. Hollis; "On the Effect of Phosphorus on Cold Shortness," by Baron Hanns Juptner von Jonstorff; "On the Determination of Hardening and Carbide Carbon," by Baron Hanns Juptner von Jonstorff; "On Malleable Cast Iron," by G. P. Royston; "On Carbon Changes connected with Malleable Cast Iron," by G. P. Royston; "On Microscope Accessories for Metallographers," by J. E. Stead, Member of Council; "On Central Blast Cupolas," by T. D. West.

Of these six were read and four discussed. Six papers were taken as read, and not discussed. The latter consisted of the papers of Messrs. Carulla, Hartley, Stead, and West, and the two papers of Baron Juptner von Jonstorff. Mr. Royston's papers were those read and not discussed.

The formal proceedings having been got through, and the report of the Council having been read, the past-President, Sir David Dale, introduced the new President, Mr. E. P. Martin, who, as is well known, is the manager of the Dowlais Iron Company of South Wales. Sir Frederick Abel was next presented with a Bessemer medal; and then the President proceeded to read his inaugural address. This was of an eminently practical nature, and gave a most interesting description of the growth of the iron and steel industry at Dowlais almost from the earliest times, these historic works having been established for over a hundred years. It is interesting to notice that in the year 1791 the quantity of coal consumed in making a ton of iron in

the South Wales district was no less than 8 tons 1 hundredweight; while the average make of pig iron per furnace per week was 20 tons. Last year the maximum output of blast furnaces at Dowlais was 1600 tons per week, the consumption of fuel (coke) being equal to about 1½ tons of coal per ton of pig. The description of the manner in which the steel industry was introduced at Dowlais and its subsequent increase was commented upon by the President; one of the first works to take up the Bessemer process being the Dowlais Ironworks. Sir Henry Bessemer himself has stated that the first ingots were made from grey Blaenavon, which was converted into soft iron or steel without spiegel or manganese, the converter being lined with Stourbridge bricks. Menelaus, Edward Williams, and Edward Riley made successful tests at Dowlais immediately after Bessemer read his historic paper at the Cheltenham meeting of the British Association; the latter only of the three gentlemen named survives, he being present at the meeting and taking part in the discussion. When Mr. Bessemer came to Dowlais to continue the experiments a convenient refinery happened to exist opposite the furnace making cinder pig, and the iron from this furnace was by a singular and most unfortunate mischance employed for Mr. Bessemer's trials. The result, naturally, was very disappointing; and it is characteristic of the troubles inventors have to meet, that it was then contended such accidents were inherent to the process. Mr. Martin states that some time ago he came across one of these Bessemer ingots, which he analysed. As might be imagined, the phosphorus was extremely high—in fact, ridiculously so, being nearly 2 per cent. Unfortunately, the mistake in regard to the pig iron was not ascertained until some time after, so that, though the Dowlais Iron Company was one of the first to take up a licence to make Bessemer steel, they did not begin to roll steel rails till 1864. It will surprise a good many people to learn that large quantities of iron rails were rolled at Dowlais as late as the year 1882. The substitution of Bessemer and Siemens steel for wrought iron has reduced the number of puddling furnaces at Dowlais from 255 to 15.

The statistical part of the address was extremely interesting, especially that relating to American competition. American iron and steel makers exceed those of this country enormously by the output they obtain from their appliances. The Carnegie Steel Works have, the President stated, again surprised the world by the tremendous strides they have made. The Duquesne furnaces hold the world's record. Their best month's work has been 17,182 tons, or 572 tons per day, the actual best day's output being 690 tons, with a consumption of coke, as an average of a month, of 1700 lbs. per ton of pig iron. That is with a 57 to 60 per cent. ore, but in our country with a 48 to 50 per cent. ore we look on a make of a little over 1600 tons per week with satisfaction. "When this is compared with the gigantic outputs obtained from the Duquesne furnaces," the President said, "during the same period, it must be admitted that the results achieved here leave much to be desired." It may be added that still larger furnaces are being erected in America, and it is confidently expected that these will produce 1000 tons of pig iron per furnace per day. The Bessemer Steel Works at Duquesne are on the same huge scale as the blast furnaces, and other American works mentioned by the President are on a similarly imposing plan. In spite of the high wages paid in America, it has been possible by working in this wholesale manner to bring the cost of production to a very low ebb, until, as has been recently stated, it is a question now not how much steel we should send to America, but how far we can meet American competition within our own boundaries. The details as to freights, iron ore supply, by-products, wages and labour cost, railway rates, and other matters of a like nature were also discussed in the address.

Mr. Hollis' contribution was the first paper to be read. The Weardale furnace is of the re-heating type—that is to say, it is used for heating slabs, &c. It would be difficult to give a description of the design without the drawings by which the paper was accompanied. The author's object was to obtain continuous working without reversing, and yet to dispense with the regenerating chambers altogether, on account of their cost. It was also a point kept in view to introduce the flame in such a way as to obtain equal heating over the whole floor of the heating chamber. The broad principle upon which these ends was effected was by constructing the furnace so that the gas-flame would be introduced through, and surrounded by, a stratum of highly-heated air in the roof of the furnace. The flame would pour down on the slabs or piles to be heated, and would pass along the floor of the working chamber to an outlet port at each end. Judging by the details given by the author in his paper, and from the testimony of many competent judges during the discussion, the Weardale furnace seems to give satisfactory results.

The next paper read was the contribution of Messrs. Arnold and Knowles. The authors stated that in passing pure carbonic oxide over white-hot aluminium the metal became coated with a grey mixture of aluminal and carbon. Also, on blowing forty gallons of carbonic oxide through molten mild steel, containing about 4 per cent. of aluminium, the percentage of carbon was raised; this power of aluminium, to reduce carbonic oxides at high temperatures, has since been used to measure the permeability to furnace gases of clay steel melting crucibles. The experiments were carried out by melting ingots of Swedish iron, containing 99·85 of iron, with calculated quantities of aluminium. The ingots were broken up and re-melted, and it was found that in each case the greater part of the aluminium had been oxidised, and that the carbon liberated had converted the iron into hard steel; in one case remarkably high in silicon, doubtless reduced from the clay of the crucible during the prolonged time the steel was maintained in a molten state. The most important practical feature of the experiment was the fact shown that the walls of a crucible form little protection against the absorption of sulphur by the metal inside it. A good discussion took place on the reading of this paper, it being opened by Prof. Roberts-Austen, who gave what was a valuable supplement to the paper, consisting of details of work of a similar nature carried out by previous investigators. This question of the porosity of crucibles was, Prof. Roberts-Austen said, the dominant problem in the minds of metallurgists early in the century. The reading and discussion of these two papers, and of the President's address, occupied the first sitting of the meeting.

The first paper taken on the Wednesday was that of Mr. Jeremiah Head, in which he described an apparatus worked by electrical power, which has been introduced in America for charging Siemens furnaces. In this country hand labour is universally adopted for the purpose, although mechanical means are about to be introduced in some works. It is by such appliances as those described by Mr. Head that the American steel-makers are enabled to obtain the enormous output to which reference has already been made. It would be difficult to describe the machine without the diagrams which Mr. Head had shown upon the wall, or the very beautiful working model which Mr. Archibald Head exhibited at the conclusion of the reading of the paper. It must suffice to say that a powerful frame or gantry is run up in front of the furnace; by means of an electric motor a massive arm is projected from this. The arm is provided with what might aptly be called a hand, which grasps the boxes containing the furnace materials entirely by automatic means. The furnace door is then opened and the arm carries the iron box, with its charge of pig iron, ore or scrap, into the furnace; by another electric motor the arm is rotated, depositing the materials into the glowing bath of the furnace. The box is then withdrawn by the arm, the operation being continued until the whole charge is in position on the hearth; the apparatus is then moved on to the next furnace. The speakers during the discussion who had seen the apparatus at work gave testimony as to its efficiency.

The last paper read and discussed at the meeting was that of Mr. Bertrand. The combined process, to which reference is made in the title, consists of two open-hearth furnaces. The operations are divided into two stages, the metal being run, when half-treated, through a header from the primary to the secondary furnace, the latter being of the nature of a finery furnace. The perfect elimination of the phosphorus is not intended in the upper furnace, and therefore less lime may be added than would be otherwise necessary, and the quantity of slag to be melted is materially diminished. The plan of working adopted consisted in charging nearly all the siliceous and phosphoric pig iron into the primary furnace, and nearly all the scrap into the finishing furnace, adding in each such quantities of ore, lime, &c., as they were demanded. The advantage claimed is an increased output and a material reduction in the consumption of lime and basic material for lining the furnace hearths; a saving of fuel also takes place, it is thought. A long discussion followed on the reading of this paper.

The summer meeting this year will be held at Cardiff.

The annual dinner of the Institute was held on Tuesday,

May 11, at the Hotel Cecil, the President occupying the chair. Among those present were the Duke of Teck, Sir Bernhard Samuelson (past President), Sir David Dale (past President), Sir Lowthian Bell, Sir Courtenay Boyle, Sir Andrew Noble, Sir Henry Mance, Prof. Dewar, F.R.S., Prof. Ayrton, F.R.S., Dr. Ludwig Mond, F.R.S., Mr. Norman Lockyer, C.B., F.R.S., and Mr. B. H. Brough (the Secretary). After the loyal and patriotic toasts had been duly honoured, Prof. W. C. Roberts-Austen, C.B., F.R.S., proposed "Scientific and Professional Societies," which was acknowledged by Sir John Evans, F.R.S., and by Mr. J. Wolfe Barry, C.B., F.R.S. The toast of the evening, "Prosperity to the Iron and Steel Institute," was proposed by Sir Courtenay Boyle.

THE CULTURAL EVOLUTION OF "CYCLAMEN LATIFOLIUM."[1]

ON the occasion of the discussion on "Variation in Plants and Animals," which took place on February 25, 1895, it occurred to me that it might be useful to give an illustration of the amount of change which has been effected in a plant by continuous selection under cultivation in a comparatively short time. I, therefore, placed upon the table an example of the wild and of the cultivated form of the garden "cineraria" (*C. cruenta*).

The choice of this species was purely accidental. It was, however, violently impugned. It was contended that the garden cineraria was not the result of the development of a single species, but that it was of multiple origin, and the result of the intercrossing of several. It was further contended that its change from the wild form had not been gradual, but by discontinuous steps or "sports." Neither contention seemed to me well founded. But I admit that, owing to the lapse of time since the so-called "improvement" of the cineraria commenced, it is impossible to give formal proof that the process has been what I described. Mr. Darwin met with the same difficulty. He remarks: "We know hardly anything about the origin or history of any of our domestic breeds" ("Origin," 6th ed., p. 29) As is, however, well known, he regarded them as the result of accumulation by selection of successive slight variations. But he also tells us that "the chance will be infinitely small of any record having been preserved of such slow, varying, and insensible changes."

It seemed to me important, therefore, to obtain the history of some cultivated species which would not be open to the objections urged in the case of the cineraria.

After some consideration I selected the plant known in gardens as *Cyclamen persicum*. Owing to the kindness of the skilful horticulturists who have worked upon it, I am able to place on record a nearly complete history of the changes it has undergone.

The genus *Cyclamen* belongs to the small order *Primulaceæ*, which in its affinities is somewhat isolated. *Cyclamen* itself is distinguished from the rest of the tribe *Lysimachieæ*, to which it belongs, by the reflexed segments of the corolla.

Cyclamen persicum, Mill., is a name given by gardeners to a form slightly modified by cultivation of *C. latifolium*, Sibth., a species confined to Greece and Syria. There is a good figure of the type in Sibthorp's "Flora Græca" (t. 185). It has pink flowers, with a ring of darker colour at the throat. The species is said to have been first cultivated in Europe at Lille in 1731 ("La Semaine Horticole," 1897, p. 23), having been introduced from Persia. There must have been some error as to its origin, for Boissier points out that the species is not found in that country ("Flora Orientalis," vol. iv. p. 12). In all probability it was obtained from Syria. The Lille plant ultimately went to Ghent, and it has been asserted that all the cultivated forms in existence are descendants from this one individual. The assertion cannot be proved, but is not improbable. It is known to have been a variety with white flowers. As will be shown, the forms now in cultivation have been derived from a white-flowered one, which in turn might well have been derived from the Lille plant.

Such a modified form was, in fact, that described by Miller, in 1768, in the eighth edition of his "Gardener's Dictionary," under the name of *Cyclamen persicum*. He describes the flowers as "pure white with a bright purple bottom." It was figured in the *Botanical Magazine* in 1787 (t. 44), and it has come down little altered to our own day. In 1875 Boissier describes it as "forma hortensis a me nunquam spontanea visa." It still exists in cultivation, and is the (old) "crimson and white" of Messrs. Sutton. It seems always to have been popular in cultivation on account of its agreeable fragrance. This confirms the Syrian origin of the original stock, for a white-flowered form "is found in Palestine which is very fragrant" (*Roy. Hort. Soc. Journ.*, N. S., vol. xiii. p. 163).

Early in the century some colour variations were in cultivation. Several as well as the typical *C. persicum* were figured in the "Flore des Serres" in 1877 (t. 2345). These record the amount of change from the wild type which had been accomplished in a century and a half. One striking seminal sport (*C. persicum*, var. *laciniatum*) is figured in the *Botanical Register* in 1827 (t. 1095). It is remarkable for spreading corolla-segments broader than usual, and cut at the edges. It does not appear to have been perpetuated, but in some degree it anticipated some of the remarkable modern developments.

I am informed by Mr. James Martin, the accomplished propagator of Messrs. Sutton, that the recent remarkable development of the cyclamen began about 1860, and, at any rate in their hands, started with the old "crimson and white." It will be seen from the accompanying figures how little this differs from the wild type. Fig. 1 represents a flower of the latter from a plant imported by Messrs. Sutton from Syria after six years of cultivation. It is not appreciably altered. Fig. 2 represents a flower of their "crimson and white"; it only differs from the wild type in having shorter, broader, and less twisted corolla segments.

In considering the progress which has been made since 1860 under the skilful hands of Mr. Martin and others, it is important

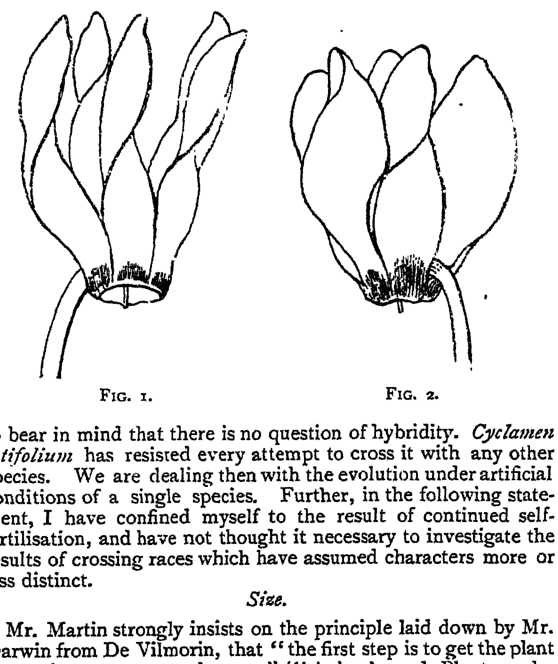


FIG. 1. FIG. 2.

to bear in mind that there is no question of hybridity. *Cyclamen latifolium* has resisted every attempt to cross it with any other species. We are dealing then with the evolution under artificial conditions of a single species. Further, in the following statement, I have confined myself to the result of continued self-fertilisation, and have not thought it necessary to investigate the results of crossing races which have assumed characters more or less distinct.

Size.

Mr. Martin strongly insists on the principle laid down by Mr. Darwin from De Vilmorin, that "the first step is to get the plant to vary in any manner whatever" ("Animals and Plants under Domestication," vol. ii. p. 262). As Mr. Martin puts it, "the breeder must work with nature." It is his practice to seize the smallest deviation, even so small an indication as the slightest difference in a cotyledon of a germinating seed. The first direction of work would, however, for commercial purposes, be to develop the size of the corolla. Figs. 3 and 4 show two stages which have been reached by progressive selection from "crimson and white." Messrs. Sutton have sent me photographs of the largest flowers hitherto produced by them. Fig. 5 is copied from one of these. The vertical depth is 3 inches. This is more than double that of the form with which they started; the increase in breadth of the segments is at least six times. This represents the continuous work of forty years. As the work was not done for a scientific purpose, the whole of the progressive steps have not been preserved or recorded. Only saleable stages have survived. But Mr. Martin emphatically denies that they have been attained by other than progressive selection, or

[1] "The Cultural Evolution of *Cyclamen latifolium* (Sibth.)." By W. T. Thiselton Dyer, C.M.G., C.I.E., F.R.S. Received and read at the Royal Society, March 18.

that they have been reached by leaps and bounds. In developing any particular character it is, to use his own words, always done by a "ladder," *i.e.* continuous self-fertilisation and selection. The stage shown in Fig. 3 owes its preservation to its having retained fragrance. Beyond this stage fragrance has been lost.

An interesting question is whether there is any limit to the extent to which an organ can be developed, and if so, what? It is to be hoped that Mr. Martin will continue his

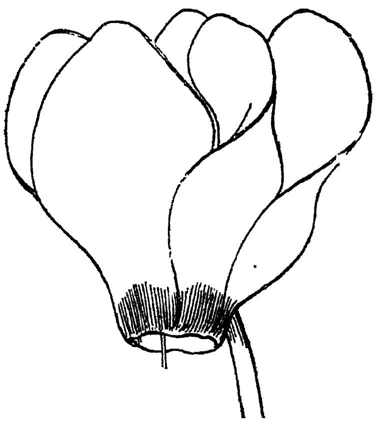


FIG. 3.

work in this direction and strive, if only as a matter of scientific interest, to increase the size of the corolla to the maximum possible. The only check will probably be found to be the general balance of nutrition.

Spreading.

I was much struck to find amongst a magnificent series of specimens, kindly sent me by Messrs. Sutton, forms with the segments of the corolla spreading instead of reflexed (Fig. 6).

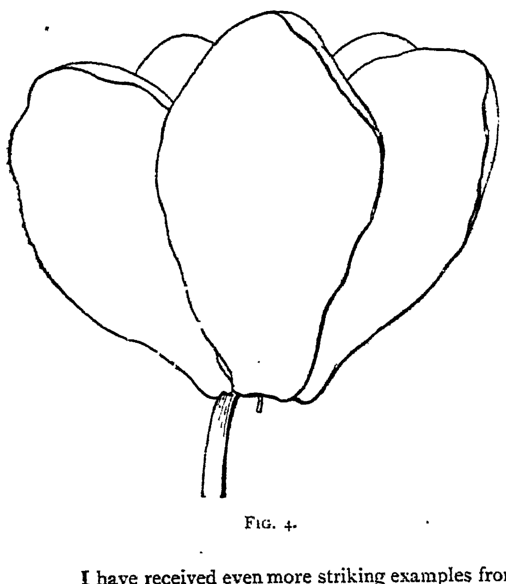


FIG. 4.

I have received even more striking examples from Messrs. Hugh Low and Co. This is remarkable because, as I have already pointed out, the latter is a distinctive generic character in *Cyclamen*. Although the alteration in the appearance of the flower is enormous, the structural change is slight. It is merely a matter of direction of growth. It amounts, however, to the loss of a generic character and a reversion to a more generalised type. The change is therefore essentially atavistic.

I was unable to obtain from Mr. Martin any explanation of how this particular variation had come about, but he informed me that it had been of frequent occurrence. Spreading flowers had always been destroyed as departing from a desirable type. More recently, on account of their orchid-like habit, they had taken the popular fancy, and had been preserved.

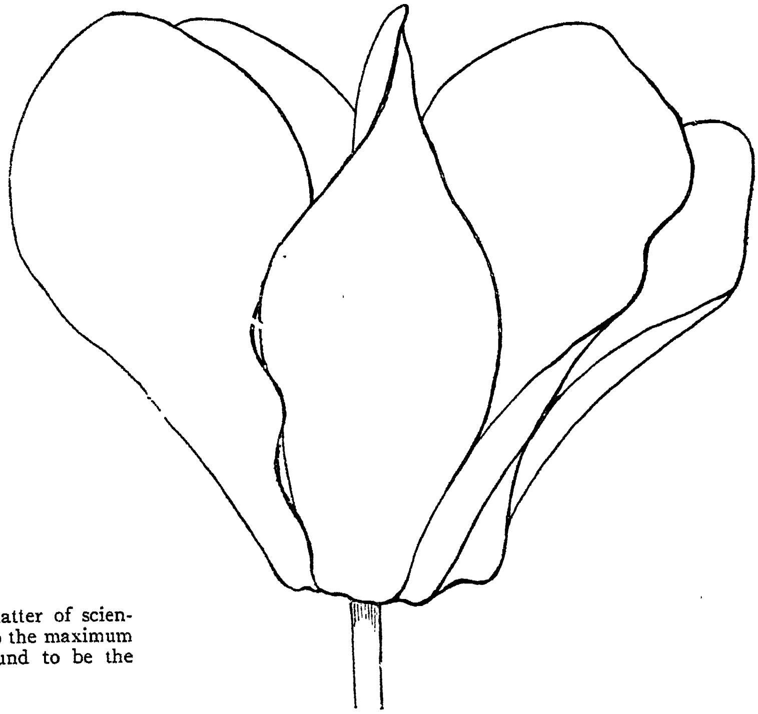


FIG. 5.

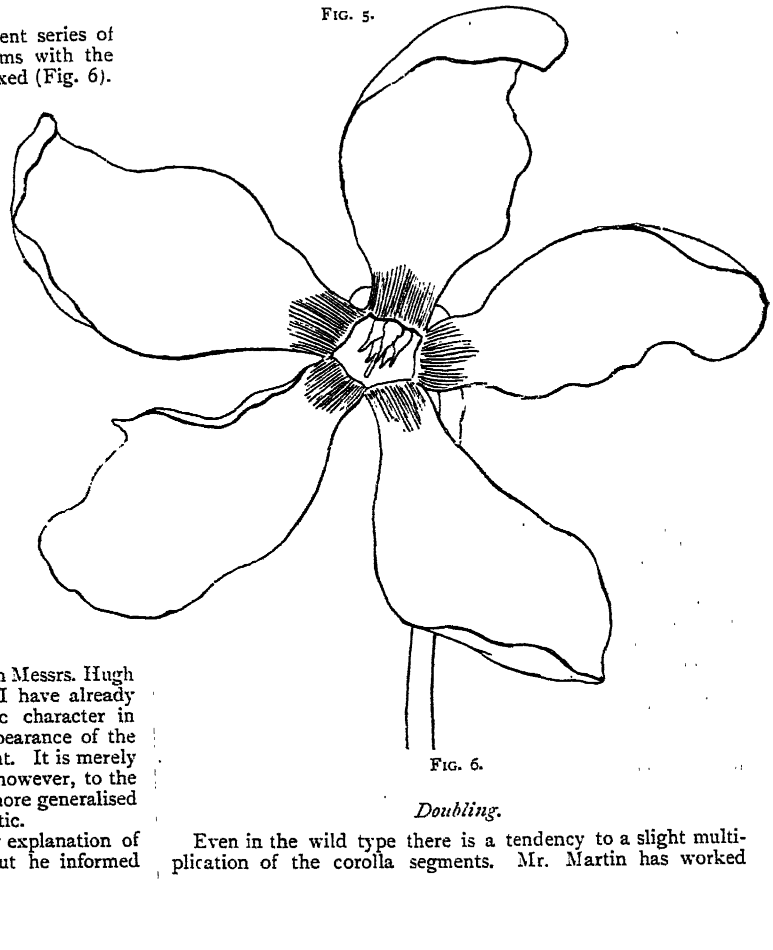


FIG. 6.

Doubling.

Even in the wild type there is a tendency to a slight multiplication of the corolla segments. Mr. Martin has worked

upon this, and has produced flowers such as shown in Fig. 7. He seems to think that there is no limit to which this multiplication cannot be carried practically, and hopes in time to produce "mop-headed" flowers like a chrysanthemum. The so-called doubling of flowers, as in the rose, is a teratological phenomenon, and is due to the conversion of stamens into petals. But in *Cyclamen* this is not the case. The stamens, which are normally equal in number to the corolla segments, are also multiplied. Although a quinary symmetry is general in the *Primulaceæ*, *Trientalis*, a near ally of *Cyclamen*, ordinarily exhibits a considerable range in the number of parts of the flower. Here again *Cyclamen*, under artificial conditions, shows a reversion to a more generalised type.

Colour.

There is evidence that seminal variation as regards colours occurred at least as early as 1820, but the modern forms with large coloured flowers, according to Mr. Martin, originated in a different way and can be traced back to the old crimson and white. That preserves the crimson ring round the throat, but is otherwise an albino. There is nothing remarkable in this. Any species in nature may produce white flowers; albinism is in effect the commonest of all variations. "Giant white" (Figs. 4 and 5) is a pure albino, in which the crimson ring has been suppressed.

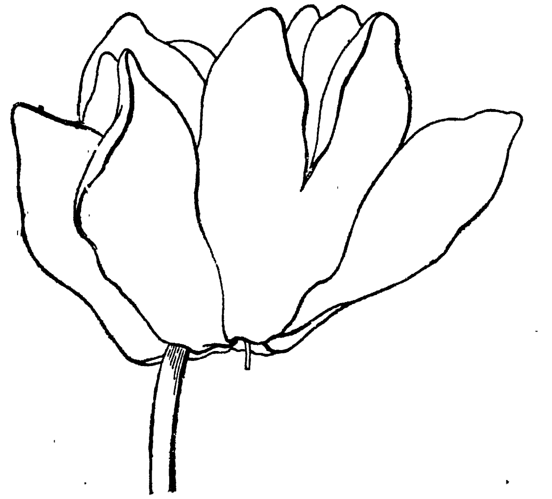


FIG. 7.

The modern coloured forms were obtained in the first instance by selecting forms in which the coloured ring showed a disposition to spread into the white corolla segments. The first indication would be a scarcely perceptible streak. By selection from self-fertilised plants the streak was widened into a stripe. Continuing the process, the stripes united, and a uniformly coloured flower was obtained.

The more striking colours, such as that of "Vulcan," which is a dark crimson, were, however, obtained not by progressive selection, but amongst the progeny of cross-fertilised plants.

I learn from Messrs. Hugh Low and Co. that coloured varieties, of course when self-fertilised, come true from seed. This is in accordance with a well-known principle (Darwin, "Cross and Self-fertilisation," p. 460).

The Butterfly Form.

This has been obtained independently by several horticulturists. The segments are partially spreading, and concave on their inner surface. One of the most remarkable is that raised by M. de Langhe-Vervaene; it is represented in Figs. 8 and 9. He informs me that "these are the products of the eleventh year of improvement." He adds: "I never crossed them with any other strain; I do not like crossing races; I prefer improving them." He has kindly favoured me with the following detailed account of the mode in which the strain has been developed and improved. I quote it in his own words:—

"Les Cyclamen Papilio que j'ai obtenus sont issus directement des *Cyclamen persicum*, var. *giganteum*.

"Il y a environ une douzaine d'années je remarquais parmi mes semis de Cyclamen une plante qui attira mon attention par l'extrême beauté de son feuillage dentelé et marbré. En examinant la plante, je vis qu'elle portait une grande quantité de boutons; ceux-ci étaient de forme plus arrondie et plus courte que ne le sont généralement ceux des *Cyclamen persicum*. La plante fut mise à part; quand elle commença à fleurir, elle m'étonna par la forme bizarre de ses fleurs. Ces diverses circonstances m'engagèrent à en recolter les graines.

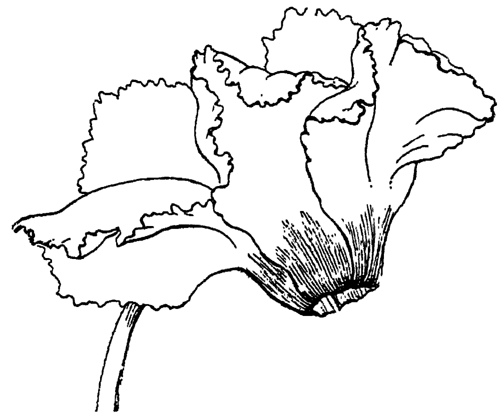


FIG. 8.

"L'année suivante j'obtins quelques jeunes plantes. Au moment de leur floraison, elles purent être comparées à la plante mère.

"Les plus parfaites de ces plantes furent choisies pour servir de porte-graine, et leurs fleurs furent fécondées entre elles. L'année suivante je fus assez heureux pour constater un nouveau progrès; mes gains surpassaient leurs parents que j'avais conservés. On pouvait apercevoir, dans ces semis aux caractères persistants, le point de départ d'une race nouvelle.

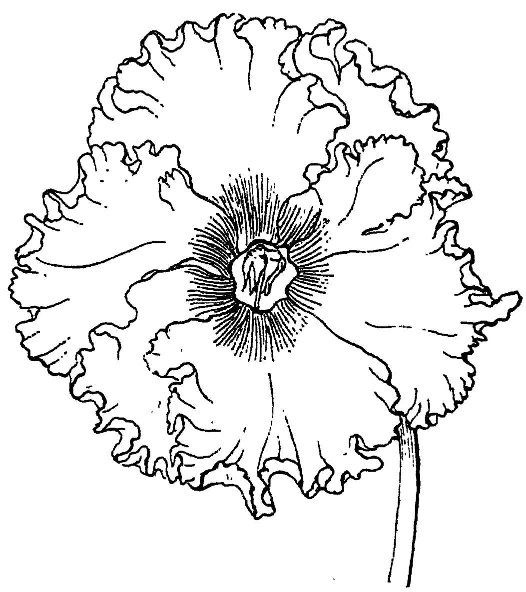


FIG. 9.

"Je continuai dans cette voie; au bout de quatre ans, j'étais en possession de quelques sujets fort remarqués. Les pétales des fleurs étaient amples et plus longs; ils se redressaient comme les ailes d'un papillon qui s'apprête à prendre son vol.

"La race se caractérisa chaque année davantage.

"Encouragé par le résultat déjà obtenu, je m'occupai à rechercher la diversité des coloris. Après quatre années je ne

possédais dans mes semis que des plantes à fleurs rouges ; j'avais en triant les sujets pour la reproduction toujours écarté les fleurs les moins brillantes. Il s'agissait maintenant d'obtenir des fleurs à couleurs pâles. Des efforts nouveaux furent fait dans cette voie ; je vis au bout de deux ans après apparaître la première fleur aux pétales blancs et à onglet rouge ; dès lors les croisements se multiplièrent au point qu'après la neuvième année la perfection des formes et des coloris est telle que tous ceux qui voient mes Cyclamen Papilio sont unanimes à reconnaître leur mérite et leur perfection des fleurs."

In this case the basis of the new strain was found in a marked variation or "sport." The deviation from the type could not, however, have been very marked. The most remarkable feature in "Papilio" as now developed is the curled and toothed margin of the corolla segments. These peculiarities repeat characters which occur elsewhere in the order. In *Soldanella* the toothing is conspicuous: curling occurs in cultivated varieties of *Primula sinensis*. It is interesting to observe in "Papilio" that in the primary variation there was a correlation between the toothing of the corolla segments and of the leaves.

Cresting.

The most remarkable form which has made its appearance under cultivation is that in which a plumose crest has developed on the inner surface of each corolla segment. This is shown in Fig. 10, which represents the "Bush Hill Pioneer," raised by Messrs. Hugh Low and Co. I quote the account of its development with which they have been so good as to furnish me:—

FIG. 10.

"This interesting variety was first observed in our nurseries some four years since, but how it originated we are unable to say.

"At that time, the only peculiarity about the variety was a *very slightly raised rib* running part of the way up the petals, and showing *no tendency to branch*. This was, however, considered sufficiently curious to follow up, and we seeded it with its own pollen.

"The young plants from this *showed a decided improvement*, the rib in some cases *showing a marked tendency to branch*. The best varieties (ten in number) were again fertilised with their own pollen, and the plants now being exhibited by us have resulted, although, needless to say, they are among the finest obtained up to the present, though *all* show a further improvement, *every flower* having a well-branched feather on the petals.

"We have this year found some colour in one plant, and we believe we shall have no trouble in obtaining crested flowers in a variety of colours."

The corolla segments of *Cyclamen* have no mid-rib. The appearance of such a structure is a reversion to the original leaf-type. The development of a crest from a mid-rib carries reversion very far back indeed. The branching of a leaf-structure in the plane in which it is expanded is common enough; branching in a plane at right angles to this is rare. Leafy outgrowths frequently occur from the mid rib in the cabbage (Masters' "Teratology," p. 455). In this case the structure of the leaf approximates to that of a stem, of which, indeed, the leaf may be regarded as a modification.

An interesting fact with regard to this singular variation is that it has appeared more than once, and independently. It first occurred in 1885, but seems afterwards to have been lost sight of (*Gardener's Chronicle*, 1885, p. 536). It has also occurred in a red-flowered form in France (*Revue Horticole*, 1897, pp. 98 and 130), in which case it was also perpetuated by seed.

I have not succeeded in discovering any similar structure in any primulaceous plant occurring in a wild state. Dr. Masters, however, informs me that it has been observed in cultivated forms of *Primula sinensis*. The tendency thus seems to be latent in the order, though why it should be so I am unable to explain.

Some theoretical interest appears to me to attach to the rapid development of so striking an ornament of a corolla segment. Such appendages are frequent enough in orchids, and are regarded as adaptations to cross-fertilisation by insects. Their gradual evolution might be thought to require a long period of time; but in the present case we have definite evidence that such a structure may be developed by selection with great rapidity.

Conclusion.

(1) The facts which I have stated appear to me to establish the result that, when once specific stability[1] has been broken down in a plant, morphological changes of great variety and magnitude can be brought about in a comparatively short space of time. This appears to me to have a very important bearing on the rate of evolution. Mr. Darwin quotes Lord Kelvin as insisting "that the world at a very early period was subjected to more rapid and violent changes in its physical condition than those now occurring"; and he adds, "Such changes would have tended to induce changes at a corresponding rate in the organisms which then existed" ("Origin," sixth ed., p. 286). That changes may be effected with considerable rapidity cannot, I think, be denied.

(2) It is further, I think, abundantly proved in the present case that, though sudden variations do occur, they are, as far as we know, slight as long as self-fertilisation is adhered to. The striking results obtained by cultivators have been due to the patient accumulation by selection of gradual but continuous variation in any desired direction.

(3) The size which any variable organ can reach does not appear to be governed by any principle of correlation. Large flowers are not necessarily accompanied by large leaves. Under natural conditions size is controlled by mechanical limitations and by the principle of economy. Nature cannot afford to indulge in anything unnecessary for the purpose in view (see Darwin, "Origin," 6th ed., p. 117).

(4) The general tendency of a plant varying freely under artificial conditions seems to be atavistic, *i.e.* to shed adaptive modifications which have ceased to be useful, and either to revert to a more generalised type or to reproduce "characters which are already present in other members of the same group" (see Darwin, "Origin," 6th ed., p. 127). This conclusion must, however, be accepted with caution, for we must remember that in a case like the present we are only acquainted with variations which have been preserved with a particular end in view.

(5) The case of "cresting" shows that the plant still possesses the power to strike out a new line and to develop characters which would even be regarded as having specific value, as in the total change which has been effected in the form of the leaf in *Primula sinensis*. If such a race developed any degree of sterility with other races, it would have satisfied Huxley's criterion for the artificial production of a new species.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Savilian Professorship of Geometry being vacant by the death of the late Prof. Sylvester, the Electors will proceed to the appointment of a successor in the course of the present Term. The duties of the Professor are defined in the following provisions of the Statutes:—"The Savilian

[1] For a general discussion of the principles of variation and specific stability, see NATURE, vol. li. pp. 459-461.

Professor of Geometry shall lecture and give instruction in pure and analytical geometry. The Professor shall reside within the University during six months, at least, in each academical year, between the first day of September and the ensuing first day of July. He shall give not less than forty-two lectures in the course of the academical year; six at least of such lectures shall be given in each of the three University Terms, and in two at least of the University Terms he shall lecture during seven weeks not less than twice a week." The emoluments of the Professorship as determined by Statute are as follows:—"He shall be entitled to the emoluments now assigned to the Professorship and derived from the benefaction of Sir Henry Savile, Knight, or from the University Chest; and shall receive in addition the emoluments appropriated to the Professorship by the Statutes of New College." The total amount of these emoluments is 900*l.* a year, and cannot exceed that amount. Applications, together with such papers as a candidate may desire to submit to the Electors, must be sent to the Registrar of the University, Clarendon Building, Oxford, on or *before* June 12, 1897.

All examinations within the University will be suspended on June 22.

Prof. Gotch, F.R.S., has been elected a Delegate for the extension of teaching beyond the limits of the University.

Mr. W. Garstang, Fellow of Lincoln College, will give a public lecture in the hall of Lincoln College on May 25, on "Recent Researches in Marine Biology."

The Botanical Museum of the Department of Botany has been undergoing rearrangement under the supervision of Mr. Church. The work is now nearly completed. Some 4000 new specimens have been added to the Herbarium during the past year.

The Curators of the Botanic Garden have presented their ninth Annual Report to Convocation. It is satisfactory to note that the deficit of last year has been considerably reduced, and a great number of exchanges with other Gardens have been made.

At a meeting of the Junior Scientific Club, held on Friday, May 14, papers were read by Messrs. E. S. Goodrich and E. F. Morris. A proposal to amalgamate with the Ashmolean Society fell through, the Club not being in a condition to bear the somewhat heavy financial burden which would be consequent on amalgamation.

An examination for the Shute Scholarship in Animal Morphology (a Non-Collegiate scholarship) is announced. It will take place in July 1897, the scholarship being of the annual value of 50*l.* Candidates must be in need of assistance at the University. The scholarship is open to all, without limit of age, with the exception of members of the University of more than eight terms' standing. Names are to be sent to the Censor of Non-Collegiate Students, High Street, Oxford, on or before Monday, June 14.

CAMBRIDGE.—The Committee for promoting the admission of women to titular degrees appears to be disintegrating. On May 17 a fly-sheet was circulated by the President of Queens' (Dr. Ryle), the Registrary (Mr. J. W. Clark), Mr. E. S. Roberts (tutor of Caius), and Mr. W. L. Mollison (tutor of Clare), expressing their decision to withdraw their support from the proposals before the Senate. They are now convinced the removal of the alleged grievance, felt by a comparatively small number of women, would be bought at too high a price, when considerably more than half of the resident members of the Senate are bitterly opposed to the measure, and would view it, if carried, as a grave betrayal of trust. They express the opinion that a victory under such conditions would be worse than a defeat, and that the passing of the Graces would prove injurious to the best interests of the University. They hope that before long a solution will be found in which the Universities of Oxford and Cambridge may act together. There is good reason to believe that the views which these influential members of the Senate have had the courage publicly to express, are shared by others who are still, nominally, on the side of the women, and that these will now either abstain from voting, or follow the lead now given to them by giving their voice against the much-discussed resolutions. The result will be declared soon after 3 p.m. on Friday afternoon, and, in the interests of peace, it is hoped that the majority will be decisive. A narrow victory for either side would settle nothing. A London Committee of about one hundred members has been formed to secure the rejection of the Graces, and is actively engaged in disseminating information and securing promises to vote *non-placet.* Lord Kelvin is chairman, and Dr. E. Freshfield secretary; among the other members are the Astronomer Royal, the Registrar of the Royal College of Physicians, Dr. Norman Moore, Lord Stanmore, and Sir Walter Besant.

Mr. W. N. Shaw, F.R.S., has been reappointed a University Lecturer in Experimental Physics.

Applications for leave to occupy the University Tables in the Zoological Stations at Naples and Plymouth are to be sent to Prof. Newton, F.R.S., Magdalene College, by May 26.

THE President of the Board of Agriculture has appointed a Departmental Committee to inquire into the working of the Universities and College Estates Acts, 1858 to 1880, and to report whether any, and, if so, what, amendments therein are desirable.

IT is perhaps worthy of notice that a new Board school, erected in Faraday Street, Walworth, at a cost of 15,000*l.*, has been named the Michael Faraday School, in honour of Faraday, who was born in the parish. May the children who receive instruction in the school strive to follow the example set them by the great investigator whose name the school bears.

THE International Submarine Telegraph Memorial Committee has granted "The Sir John Pender Gold Medal," value 5*l.* 5*s.*, to the Glasgow and West of Scotland Technical College. It is given annually to the best student who at the same time obtains the college diploma in electrical engineering. At the end of this session, which terminated last week, it was awarded to Mr. David Robertson.

Science announces the following gifts to educational institutions in America:—The will of the late John Foster, of Boston, gives 120,000 dols. to public purposes, including 10,000 dols. to the Massachusetts Institute of Technology; the will of the late Charles Bell, of Springfield, Mass., bequeaths 7000 dols. to Wellesley College for a scholarship fund; Brown University receives 10,000 dols. by the settlement of the will of the late Mrs. Maria L. Benedict, of Providence.

IN the House of Commons, on Monday, Mr. Brynmor Jones asked the First Lord of the Treasury whether it was the intention of the Government to reintroduce the University of London Bill this Session; and, if so, when. In reply to the question, Mr. Balfour said that the President of the Council hoped to introduce a Bill into the House of Lords shortly. There is some reason to expect that the difficulties, which prevented it from passing last year, will be removed, and certain negotiations are going on with that object.

THE following are among recent appointments:—Mr. C. H. Warren to be Instructor in Mineralogy in the Sheffield Scientific School of Yale University; Dr. Karl Paal to be Professor of Chemistry at Erlangen; Dr. Raphael Freiherr von Erlanger, privat-docent in Zoology at Heidelberg, to be Professor; Dr. F. Foerster, privat-docent in Chemistry at the Dresden Technical High School, to be Professor; Dr. Petzold, privat-docent in Practical Geometry at the Technical High School at Hanover, to be Professor; Dr. Anding, privat-docent in Astronomy at Munich, to be Observer on the International Commission for the Measurement of the Earth; Dr. J. Thomayer to be Professor of Pathology at the Bohemian University at Prague; Mr. J. F. Crawford to be Demonstrator in Experimental Psychology in Princeton University.

IN October last a Committee was appointed "to inquire into the mode in which the grants to Science and Art Schools are distributed, and to report whether any alteration should be made therein." The Report of this Committee has just been published as a Blue-book, in which is also included a revised edition of the Science and Art Directory, embodying the recommendations of the Committee. Some of the important changes advocated are as follows:—(1) "In counties and county boroughs in England possessing an organisation for the promotion of secondary education, the authority so constituted may notify its willingness to be responsible for the science and art instruction within its area." This recognition of local authorities as those who should be responsible for secondary instruction will, the Committee thinks, simplify the work of central administration, secure greater efficiency in the schools, and be a protection against this undue competition and multiplication.

(2) To encourage the study of languages and literary and economic subjects, and to meet the objection that the Science and Art grants tend to promote a one-sided education, it is proposed that any *bonâ fide* student attending an evening science or art class shall be able to earn a grant by attendance at University Extension courses of lectures. It is expected that the grants made on this account will only absorb an infinitesimal proportion of the total grants disbursed by the Department of Science and Art. (3) Hitherto certain restrictions as to income have existed which precluded some students from earning grants or winning scholarships. These are to be abolished; but, to prevent abuse, a regulation has been added that schools in receipt of payment must be "approved by the Department as suitable in character and financial position to receive aid from public funds," and with reference to persons eligible to hold certain scholarships and exhibitions, a provision has been added that "the Department may refuse to fill them with persons whose circumstances do not appear to warrant such aid." (4) It is suggested that the Honours examination in each subject should be divided into two parts, one less advanced in character than the other.

LORD HERSCHELL, the Chancellor of the University of London, took the opportunity of referring to the need of a teaching University, at the meeting held on Wednesday in last week for the distribution of medals and certificates. A University was not worthy of the name, he is reported by the *Times* to have said, unless it inspired a love of knowledge for its own sake. It was this conception of the mission of a University which made him desire to introduce a different element into their University, so that it should no longer be the main object of its members to obtain degrees; and if, even as regarded a minority of students, the function of teaching were added to that of examining, the idea of a University would be realised in a far higher degree than it was at present. The question of a change in their constitution had been before the country for many years, and he would not approach it in a controversial spirit, but he could not but express a hope that some step would soon be taken. The discussions of the last two years had removed many misconceptions between those who held widely different views from each other; and the progress of consideration and the interchange of views might, he thought, lead to approximation between those who appeared to stand asunder. But he was inclined to think that the questions at issue might better be solved by an independent body than by mutual concessions on the part of opposing parties. The danger of compromise was that each side might concede something which ought not to be conceded—a danger which an independent body might avoid. The main objection urged against change was that it might tend to lower the quality of degrees. If that were likely to be the result, he should be the enemy of change; but he did not believe it passed the wit of man to devise means whereby the University should become a teaching body and yet both maintain its present high standard and safeguard the interests of external students. Certainly those members of the Senate who were favourable to change were the last men who would wish to lower the degree standard. But he wished to point to a real danger. There could be nothing more fatal to the prestige and influence of their University than that there should arise by its side another University in London which should teach as well as examine; and if the choice lay between such a second University and the modification of the existing University of London, surely the latter alternative was preferable. The feeling in favour of a teaching University was so strong that in one form or another it must succeed in its aim, and surely it was wiser to look facts in the face than blindly to oppose the inevitable march of events.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 14.—Mr. Shelford Bidwell, President, in the chair.—Mr. W. Watson described an instrument for comparing thermometers with a standard. The thermometers to be compared are inserted together in an enclosed vapour-tube, the temperature of which can be maintained very constant at different parts of the scale. The apparatus is an adaptation of the arrangement designed by Ramsay and Young for vapour densities. It consists of a wide vertical glass tube, with a narrower tube attached at the top. The narrow tube bends downwards, and communicates with a closed vessel of considerable volume. A portion of the vertical tube is surrounded by a condensing-jacket, and a manometer-tube is inserted near the top. The object of the large vessel is to diminish errors arising from fortuitous changes of pressure, resulting from small leakages or "bumping" of the boiling liquid. Electrical heating of the bulb containing the liquid, effectually removes the "bumping." The following liquids, used consecutively, give a range of temperature from 20° C. to 120° C.: carbon bisulphide (20° to 46°), ethyl alcohol (80°), chlorobenzine (120°). The apparatus when once started required very little attention; from results submitted by the author, the variations do not exceed 0·02° C. per hour. In constructing the various parts, the difficulties of glass-blowing are reduced by making the joints of india-rubber stoppers, attached to the glass with india-rubber solution. Each joint is jacketed with glycerine. If the above liquids are used in the vaporiser, the scales of the thermometer can always be read within the tube; it is only with water that the condensed vapour gives trouble. Prof. Ayrton thought the apparatus would come into extensive use; it did away with errors arising from differences of length of thermometer stems; it left no question as to the equality of temperature of the two bulbs; and there was no probability of error due to a difference of thermal "lag" in any two thermometers. Mr. Watson, in replying to a question of Prof. Perry's, said the fact of using india-rubber joints limited the available range of temperature. Working with blown joints, Ramsay and Young had found no difficulty with their vapour-density experiments at higher temperatures.—Prof. Carey Foster read a paper, by Mr. D. K. Morris, of Zürich, on the effect of temperature upon the magnetic and electric properties of iron. The investigation relates to the measurement of the magnetic permeability, hysteresis, and electrical resistance of iron, simultaneously, at different temperatures. The specimens are formed into annular rings, made from iron strip. The strip is first lapped round with asbestos paper and mica, and then wound upon itself to the required thickness. A platinum wire is included in the mica lappings, for thermometrical purposes. Upon each annular ring are the following windings: (1) a primary magnetising coil; (2) a secondary coil connected to a ballistic galvanometer; (3) an electrical heating coil. Further, the iron strip is itself connected to a Wheatstone's bridge, for resistance measurements. The coil can be heated to 1050° C. At the higher temperatures, the surrounding air has to be freed from oxygen; this is done by enclosing the coil in a suitable vessel, and exhausting with an air-pump. When most of the air has thus been removed, the residual oxygen is absorbed by an electrically-heated iron wire. Curves are drawn representing the changes of permeability at the different temperatures; and, at the same temperatures, the corresponding hysteresis loops are plotted. The hysteresis diminishes with temperature; it nearly vanishes at about 764° C. At the suggestion of Prof. Ayrton, it was agreed that the discussion on this paper should be adjourned until the publication of the results. The paper will, therefore, be printed without delay.—Mr. Rollo Appleyard read a paper on the formation of mercury films by an electrical process. If a sheet of damp leather, or similar permeable substance, is used as a separating diaphragm between two bodies of mercury, and a current is sent through it, a film of mercury is deposited upon the surface connected to the positive pole; and the film remains on the diaphragm after removal from the apparatus. If the diaphragm is replaced in the apparatus, and subjected to a current in the reverse direction, the film vanishes from that surface, and a second film appears on the other side; that is to say, the film is always on the side of the diaphragm connected to the positive pole of the battery, and there is no film on the negative surface. Different diaphragms and films were exhibited on filter-paper, asbestos-paper, plaster of Paris, &c. A current of about one-fiftieth of an ampère, or more, is necessary. A sheet of tinfoil included between folds of filter-paper becomes perforated with pin-holes when the current is passed between the outside surfaces. This happens whether the outside electrodes are mercury or metal plates. If the top electrode should be tinfoil, this also becomes perforated as well as the included sheet. A further experiment was shown in which a gold coin is placed upon the folds of filter-paper; the current produces a gold-discoloration which penetrates the folds. This, it was suggested by the author, may help to account for the formation of metallic lodes and veins as they exist in rocks;

and they may partly explain the "inductoscripts" of Mr. F. J. Smith. Dr. S. P. Thompson said he did not know of any other example of an *anode* being more active, mechanically, than the *kathode*, except the electric arc. He was surprised that the film should appear on the positive surface. Mr. Shelford Bidwell thought selenium presented, in some of its actions, an example of the *anode* being thus active. Prof. Ayrton said that if a vessel containing a substratum of mercury amalgam was filled up with water in which gold crushings were washed, the gold descended into the amalgam. This, however, might be due partly to gravity, and partly to simple electrolysis. Mr. Appleyard said he had no definite views as to the formation of the films. He believed it to be a secondary effect of electrolysis, aided by electric osmosis. The experiments of Mr. C. K. Falkenstein upon the electric tanning of leather, and the early results of M. Perret, helped the idea of electric osmosis; they were not sufficient, however, to justify that theory without further research. A careful chemical analysis of the deposits left in the folds of filter-paper would be the best guide.

EDINBURGH.

Royal Society, May 3.—Prof. Chrystal in the chair—A paper on Dschâbir Ben Hayyân and the chemical writings ascribed to him, by Prof. Ferguson.—The seasonal changes in the pressure and temperature of the atmosphere from May to June, and November to December, by Dr. Buchan.—Dr. W. W. J. Nicol read a paper on supersaturation. After a short reference to his previous papers on supersaturation, in which the author showed that supersaturated solutions differ in none of their properties from ordinary solutions, if only the temperature be not allowed to fall below a certain point (depending upon the nature of the salt in question, and the concentration of the solution), and contact with the solid salt or with an isomorphous salt be carefully prevented, he repeated his statement that there is really no such thing as a supersaturated solution, that such solutions are in reality saturated or non-saturated solutions of what may be termed the anhydrous salt; that is to say, they contain the salt to which the *whole* of the water is similarly related, no distinction existing in solution between the water organically present as water of crystallisation, and the solvent water. The author proceeded to explain that he was forced into premature publication of his recent work on the subject, by the appearance of a paper by Ostwald in the last number of the *Zeitschrift für Physikalische Chemie* (see pp. 61-2.) In this paper, Ostwald was apparently on the verge of coming to the same conclusions as those at which the author had arrived as the result of his more recent work, thus no other course was open to him than the publication of the work in an incomplete form. The conclusion at which the author has arrived is as follows. Whenever, under the conditions of experiment, two allotropic forms of the dissolved or fused substance can exist, then supersaturation or superfusion, as the case may be, is also possible. In other words, allotropy is the cause of supersaturation. The term allotropy is used in a wider sense than usual; here it includes different crystalline or amorphous forms of a body brought about by the presence or absence of foreign molecules, and the statement is therefore applicable to cases of supersaturation involving hydrated salts, and also double salts. The experimental evidence in favour of the above, though incomplete, is already fairly large. The law is found to hold good not only with hydrated salts, but also with salts crystallising usually without water and with numerous organic compounds. Thus, allotropic forms have been found, and supersaturated solutions prepared, in the case of potassium nitrate, ammonium nitrate, silver nitrate, acetonilid, hydroquinone, acetamide, malonic acid, mandelic acid, resorcin, tartaric acid, citric acid (four modifications), and sodium chlorate, this last observed first by Ostwald. The author intimated his intention to examine further as to the limits, and to investigate the border region in which supersaturation can be terminated by shock or other mechanical means.—A paper on the geometrical investigations of the circular functions of 3θ and 5θ, by Prof. Anglin.—On some nuclei of cloudy condensation, by John Aitken, F.R.S. It has been claimed, the author said, by Helmholtz and Richarz, that "ions" were active in producing condensation in supersaturated vapour, and that these, along with dust, produced the ordinary cloudy condensation in the atmosphere. In an experiment by the author to test this conclusion, hydrogen was burned in filtered air, when it was found that, if precautions were taken to have the hydrogen pure and the air absolutely dust free, the ions lost their power of producing cloudy condensation as soon as they were cooled. The products of combustion remained free from condensed particles, when expanded, and when the products were tested by means of steam near the combustion-chamber, while they were still hot, they showed very little power of condensing. It had been shown in a previous paper that sunshine gave rise to a great increase in the number of particles under certain conditions, and experiments, recently made, were described in which it was shown that, though sunshine has no effect in producing nuclei in ordinary air, yet, if any of the so-called impurities in the atmosphere be present there in the gaseous condition, the sunlight produces a great number of nuclei. It was found that if ammonia, peroxide of hydrogen, nitric acid, nitrous acid, or sulphurous acid, were present in the air, sunlight caused the formation of a great number of nuclei of condensation, showing that if any of these gases are present in the air, clouds would be produced, though there was no dust present, if the air became saturated.

PARIS.

Academy of Sciences, May 10.—M. A. Chatin in the chair.—The President announced the losses the Academy had sustained by the deaths of M. Des Cloizeaux and Mgr. le duc d'Aumale.—Explanations of some experiments of M. G. Le Bon, by M. Henri Becquerel. Experimental evidence is given showing that vulcanite is transparent to the red and infra-red rays, which, although without action upon an unexposed plate, are capable of continuing the action of the actinic rays upon a plate which has been exposed for a very short period of time. These red rays are also capable of destroying the phosphorescence of zinc sulphide, and their passage through the vulcanite affords a complete explanation of the observations of M. G. Le Bon, the assumption of the existence of a special kind of light, "dark light," being unnecessary.—On solutions of acetone and their explosive properties, by MM. Berthelot and Vieille. This paper is a lengthy one, and gives the pressures of acetylene dissolved in acetone at different temperatures and concentrations, the conditions under which dissolved acetylene explodes; and also acetylene gas in contact with its solution in acetone.—Remarks on the explosive decomposition of solutions of acetylene, by MM. Berthelot and Vieille. In the explosive decomposition of solutions of acetylene in acetone, the latter is also broken up into carbon, hydrogen, water, and the two oxides of carbon.—On some conditions of propagation of the decomposition of pure acetylene, by MM. Berthelot and Vieille. It was found to be impossible to obtain a critical pressure below which the propagation of the explosive wave did not take place, as in a series of experiments at a given pressure the wave was sometimes produced and sometimes not.—On the employment of four-dimensional space in the study of algebraic surfaces admitting several series of conics, by M. Eugène Cosserat.—On an analytical formula relating to certain integrals of elliptic functions with respect to their modulus, by M. F. de Salvert.—On the algebraic integration of linear differential equations of the third order, by M. A. Boulanger.—On the solubility of liquids, by M. A. Aignan. The method of Alexejew for the study of the mutual solubility of liquids is criticised, and a new method suggested which leads to a different definition of the coefficient of solubility. The formulæ deduced are applied experimentally to the case of ether and water.—On multiple resonance, by M. L. Décombe. The experiments cited entirely confirm the theory of resonators put forward by Poincaré and Bjerknes.—On the diurnal variation in the direction of the wind, by M. Alfred Angot. In order to get rid of the disturbing effects of surrounding buildings, the observations were carried out at the top of the Eiffel Tower.—Basic salts of cadmium, by M. Tassilly.—Researches on strontium sulphide, and on the method of obtaining it highly phosporescent, by M. José Rodriguez Mourelo. The sulphide is prepared by heating a mixture of strontium carbonate, sulphur, sodium carbonate, sodium chloride, and bismuth sub-nitrate.—Thermal study of the sodium derivatives of acetylene, by M. Camille Matignon.—Contribution to the study of the preparation of ordinary ether, by M. L. Prunier. Some sulphonic acids are always present in addition to the sulphate and ethyl sulphate previously noted.—Action of chloral hydrate upon phenylhydrazine. Diphenylglyoxazol and its derivatives, by M. H. Causse.—On the effect of manganese in the oxidations induced by laccase, by M. Gabriel Bertrand. The presence of a manganese salt increases the

oxidising power of laccase to a remarkable extent. The author points out that the presence of minute traces of manganese in plants may be of great physiological importance.—On the fauna of the pools on the eastern coast of Corsica, by M. Louis Roule.—On a disease of orchids caused by the *Glœosporium macropus*, Sacc., by M. Mangin. After detailing the methods employed in ascertaining the presence of the *Glœosporium* in the affected plants, measures are suggested for fighting the disease, chiefly the use of β-naphthol.—On the mode of formation of the primary dunes of Gascony, by M. E. Durègne.—On the general course of glacial denudation, by M. Stanislas Meunier.—Experiments showing that the liver destroys dissolved hæmoglobin, and that it keeps the iron, by M. Louis Lapicque.—The number of poisonous principles produced by a pathogenic microbe, by M. A. Charrin. The idea is attacked that a specific pathogenic organism produces one specific poisonous principle, its toxin, and experiments are quoted to show that one and the same species of microbe can produce several pathogenic compounds. Thus the pyocyanic bacillus is shown to produce several, easily distinguishable by their pathological effects.—On barley, by M. Balland. Some proximate analyses of barley.—On the dialysis of the alkaline humates, by M. J. Dumont.—Remarks on some properties of the oxydase in wines, by M. Bouffard.—Research on caramel. Possible confusion with coal tar-colours, by M. Antonio J. da Cruz Magalhaes.

DIARY OF SOCIETIES.

THURSDAY, MAY 20.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture—On the Mechanical Equivalent of Heat: Prof. Osborne Reynolds, F.R.S., and W. H. Moorby.

SOCIETY OF ARTS, at 4.30.—Kerman and Persian Beluchistan, with special reference to the Journeys of Alexander the Great and Marco Polo: Captain P. Molesworth Sykes.

CHEMICAL SOCIETY, at 8.—The Theory of Osmotic Pressure and the Hypothesis of Electrolytic Dissociation; Molecular Rotation of Optically Active Salts; Heats of Neutralisation of Acids and Bases in Dilute Aqueous Solution: Holland Crompton.—The Platinum-Silver Alloys: their Solubility in Nitric Acid: John Spiller.—A Comparative Crystallographical Study of the Normal Selenates of Potassium, Rubidium and Caesium: A. E. Tutton.

FRIDAY, MAY 21.

ROYAL INSTITUTION, at 9.—Contact Electricity of Metals: Lord Kelvin.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Tunbridge Wells), at 3.30.—What can be done to save our Fauna and Flora from unnecessary Destruction? : Rev. J. J. Scargill and A. Rose.—How can the Technical Education Grant assist Local Scientific Societies? S. Atwood and J. W. Tutt.—Local Museums: Practical Observations on Objects and Methods: W. Cole and E. A. Pankhurst.

EPIDEMIOLOGICAL SOCIETY, at 8.

SATURDAY, MAY 22.

ROYAL BOTANIC SOCIETY, at 4.

GEOLOGISTS' ASSOCIATION—Excursion to Erith and Crayford. Director: Flaxman C. J. Spurrell. Leave Cannon Street (S. E. R.) at 2.2.

LONDON GEOLOGICAL FIELD CLASS.—Excursion to Tunbridge Wells. Wealden Beds. Leave Cannon Street, 2.23: arrive Tunbridge Wells, 3.40.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Tunbridge Wells), at 11.—The Committees of Field Clubs: Prof. G. S. Boulger.—Current Bedding in Clay: Section at New Athletic Ground, Tunbridge Wells: Prof. H. G. Seeley, F.R.S.—Search for Coal in the South-east of England: H. E. Turner and W. Whitaker, F.R.S.—History of the Weald in special reference to the Age of the Plateau Deposit: W. J. Lewis Abbott.

MONDAY, MAY 24.

SOCIETY OF ARTS, at 8.—Design in Lettering: Lewis Foreman Day.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

TUESDAY, MAY 25.

ROYAL INSTITUTION, at 3.—The Heart and its Work: Dr. E. H. Starling.

ROYAL STATISTICAL SOCIETY, at 5.30.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Quinary System of Notation used in Luchoo: Prof. Basil Hall Chamberlain.—Ancient Measures in Prehistoric Monuments: A. L. Lewis.——*Probable* Papers: Further Discoveries of Stone Implements in Somaliland: H. W. Seton-Karr.—The Berbers of Morocco: W. B. Harris.—Rock Paintings and Carvings of Australian Aborigines: R. H. Mathews.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Optical Effects of Intensification: Chapman Jones.—Some Notes on the Correct Rendering of the Colours of Flowers: H. T. Malby.

ROYAL VICTORIA HALL, at 8.30.—Growth of the Colonies in the Queen's Reign: O'Donnell.

WEDNESDAY, MAY 26.

GEOLOGICAL SOCIETY, at 8.—On Augite-Diorites with Micro-Pegmatite in Southern India: T. H. Holland.—The Laccolites of Cutch and their Relation to the other Igneous Masses of the District: Rev. J. F. Blake.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, MAY 27.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 28.

ROYAL INSTITUTION, at 9.—The Isolation of Fluorine: Prof. H. Moissan.

PHYSICAL SOCIETY, at 5.

SATURDAY, MAY 29.

LONDON GEOLOGICAL FIELD CLASS.—Excursion to Sheerness. Drive to East Church, Hensbrook. London Clay. Leave Holborn Viaduct, 1.25.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Exercises in Practical Physiology: Dr. A. D. Waller, Part 3 (Longmans).—Milk and its Products: Prof. H. H. Wing (Macmillan).—The Theory of Electricity and Magnetism: Prof A. G. Webster (Macmillan).—The Elements of Physics: E. L. Nichols and W. S. Franklin, Vol. 3 (Macmillan).—Prehistoric Problems: Dr. R. Munro (Blackwood).—A Great Agricultural Estate: The Duke of Bedford (Murray).—The Localisation of Faults in Electric Light Mains: F. C. Raphael (*Electrician* Company, Ltd.).—The Birds of our Country: H. E. Stewart (Digby).—Handbook for Jamaica for 1897 (Stanford).—Reports from the Laboratory of the Royal College of Physicians, Edinburgh, Vol. 6 (Edinburgh, Clay).—Memories of the Months: Sir H. Maxwell (Arnold).—Government of India, Department of Revenue and Agriculture. Accounts of the Trade carried by Rail and River in India, 1895–96, and the Four Preceding Years (Calcutta).—Electromoteurs et Leurs Applications: G. Dumont (Paris, Gauthier-Villars).—The Development of the Frog's Egg: Prof. T. H. Morgan (Macmillan).—Flowering Plants: Mrs. A. Bell (Philip).—First Stage Mechanics of Fluids: Dr. G. H. Bryan and F. Rosenberg (Clive).—Social Transformations of the Victorian Age: T. H. S. Escott (Seeley).—Topographische Anatomie des Pferdes: Profs. Ellenberger and Baum, Dritter Teil (Berlin, Parey).—Report on the Geological Structure and Stability of the Hill Slopes around Naini Tal: T. H. Holland (Calcutta).—Leçons sur L'Electricité et le Magnétisme: Prof. E. Mascart, tome deuxième (Paris, Masson). Essai sur les Éléments de la Mécanique des Particules: H. Majlert, 1re Partie: Statique Particulaire (Neuchatel, Attinger).

PAMPHLETS.—Geological Survey of Canada: Report on the Country between Athabasca Lake and Churchill River: J. B. Tyrrell and D. B. Dowling (Ottowa).—Ditto: Report on Explorations in the Labrador Peninsula along the East Main, &c., in 1892, 1893, 1894, and 1895: A. P. Low (Ottawa).—Resultate aus den Beobachtungen des Veränderlichen Sternes η Aquilae: W. J. S. Lockyer (Göttingen).

SERIALS.—Transactions of the Astronomical and Physical Society of Toronto, 1896 (Toronto).—Palæozoic Fossils: J. F. Whiteaves, Vol 3, Part 3 (Ottawa).—Engineering Magazine, May (Tucker).—Proceedings of the Royal Society of Victoria, Vol. ix., new series (Melbourne).—Quarterly Journal of the Geological Society, Vol. liii Part 2, No. 210 (Longmans).—General Index to the First Fifty Volumes of the Quarterly Journal of the Geological Society, Part 2 (Longmans).—Journal of the Institution of Electrical Engineers, No. 128, Vol xxvi. (Spon).—Memoirs of the Geological Survey of India. Palaeontologia Indica, ser. xvi. Vol. 1, Part 1 (Calcutta).—Memoirs of the Geological Survey of India, Vols. xxv. and xxvi. (Calcutta).—History of Mankind: F. Ratzel, translated, Part 19 (Macmillan).—American Naturalist, May (Philadelphia).—Journal of the Franklin Institute, May (Philadelphia).—Psychological Review, May (Macmillan).—Ditto, Psychological Index, No. 3 (Macmillan).—Journal of the Chemical Society, May (Gurney).—English Illustrated Magazine, June (198 Strand).

CONTENTS. PAGE

THURSDAY, MAY 27, 1897.

THE COLLECTED PAPERS OF PROFESSOR ADAMS.

The Scientific Papers of John Couch Adams, M.A., Sc.D., D.C.L., LL.D., F.R.S., late Lowndean Professor of Astronomy and Geometry in the University of Cambridge. Vol. i. Edited by W. G. Adams, Sc.D., F.R.S. With a memoir by J. W. L. Glaisher, Sc.D., F.R.S. Pp. liv+502. (Cambridge: University Press, 1896.)

TO collect with completeness, and to edit with care and reverence, the scientific work of those whom the world has followed with close and respectful attention, must be a grateful and, at times, a necessary task. The opportunities of publication are fortunately numerous, for many learned societies and scientific bodies are eager to make known the researches of those whom they are proud to reckon among their associates or supporters. Obviously, this general scattering is attended with many evils, which collection will effectually remove. Not only will readier access be given to the student to those papers in which he is interested, but the reputation of the author will probably be enhanced by the greater coherency which his work is likely to acquire. In the present instance, however, though the result will be welcomed by many, the necessity for collection is not so apparent as in some other famous cases. The number of published papers is not large—sixty-two in all, of which five are addresses from the presidential chair to the recipients of the medals of the Royal Astronomical Society, and a few others, the results of observations connected with the direction of the Cambridge Observatory. Of the more important papers, each is usually complete in itself, since it was seldom necessary for Adams to return to a subject which he had once discussed. Neither did Prof. Adams select many channels by which to make his thoughts and results known to the world. The Astronomical Society sufficed him for the greater part, and their publications are readily accessible, though it must be admitted that the Council of that Society have very recently found themselves compelled to republish one of his more interesting papers.

Dr. Glaisher contributes an appreciative account of Adams's life. Without containing many new facts, it shows a keen insight into his character, and makes the reader understand in some measure, the reason why Adams maintained so pre-eminent a position among his contemporaries. The thoroughness with which he did his work, the innate craving after perfection, the steady maintenance of a high standard of excellence, the dislike to hurried and incomplete publication, all contributed to give him that superiority which he never courted, and to make him an authority whom all respected. Naturally, the history of the discovery of Neptune figures largely in the biographical notice. It is a subject that apparently never wearies, and concerning which the last word will never be written. But all the material facts have long since been threshed out, and there is no new source from which any fresh information can be derived. Dr. Glaisher permits himself to criticise in some particulars the conduct of both Airy and Challis.

"Adams was not fortunate," he says, "in the two astronomers to whom he communicated his results; neither of them gave to a young and retiring man the kind of help or advice that he should have received. . . . As Professor in the University, he (Challis) should not have allowed a young Senior Wrangler, through modesty or diffidence, to do such injustice to himself. . . . It is impossible not to contrast the admiration with which he (Airy) received Le Verrier's published writings with the indifference shown towards Adams's still unpublished work. Adams was certainly as clearly convinced of the reality of the planet as Le Verrier, and whatever claims the latter has to the name of philosopher rather than mathematician, apply equally to the former."

This is no doubt true, but it does not seem to be as distinctly remembered as it should be that Adams in fame and reputation suffered no irreparable injury. Greater attention could not have been drawn to the excellence and originality of his work, or the philosophic character of the original conception, than was occasioned by the untoward circumstances that surround the discovery of Neptune. Though no one sought less for public applause than did Adams, the effect of the controversy was to advertise his merits far more widely than would have been the case, if Le Verrier's papers had not appeared. The immediate effect was to place Adams at one bound in the front rank of astronomers; and perhaps there is no other instance, in scientific life, of a reputation so assured being so swiftly won. He presents the singular—perhaps the unique—instance of a young man being unable to add to his rapidly acquired reputation. That the high level at which he commenced his career was amply sustained, will of course be universally admitted; but it was almost impossible that it could be raised, in the public mind, at least.

The investigation of the perturbations of Uranus, of course, occupies the first place in the collected series of papers; and to this discussion is added, as a matter of historical interest, some of the earliest observations of Neptune made by Prof. Challis, as well as an account of the zonal measurements made at the instance of the late Astronomer Royal, with a view to the detection of the planet prior to the actual discovery at Berlin. More interest, however, attaches to a reference to a reprint of Adams's original paper in Liouville's *Journal de Mathématiques* for 1875, because it is accompanied by a less known note, that Prof. Adams contributed in reply to some criticisms of Prof. Pierce. Very shortly after the discovery of the planet, Prof. Pierce had contended that the true period of Neptune differed so widely from that assigned by Adams to the hypothetical planet, that the discovered object was not the planet indicated by geometry, and that in fact its discovery must be regarded as a happy accident. The main contention of Prof. Pierce was that the commensurability of the mean motion of Uranus with that of Neptune would give rise to perturbations always in the same part of the orbit of the inferior planet, whereas the perturbations due to the hypothetical planet would not occur with the same regularity, but would vary 80° upon the orbit of Uranus, at each successive conjunction and opposition. Adams had little difficulty in disposing of this criticism, though

this collection of papers would indicate that he took no notice of it for thirty years. He then points out that the objection would be valid if it were sought to explain the perturbations of Uranus throughout one or more whole synodic periods of the planet. Practically, and for the purposes of the particular solution, the action of the disturbing planet on the motion of Uranus is limited to some twenty years before and after 1822, when the two planets were last in conjunction. The preceding conjunction took place in 1650, some forty years before Flamsteed's earliest observation, and the sensibly elliptic orbit in which Uranus was moving from that time to the beginning of the century, was the elliptic orbit on which the perturbations of Neptune at the last conjunction had been impressed. The outstanding discrepancy exhibited by Flamsteed's observation, in 1690, from the place indicated by the theories of both Adams and Le Verrier, arose from the inadequacy of those theories to represent the place of the planet in the remote past, owing to the erroneous distance assigned to the hypothetical planet.

Passing over a few short papers generally referring to the orbits of comets and of double stars, we come to Adams's work on the Moon. The papers on this subject refer to lunar parallax, the secular acceleration of the moon's mean motion, and critical notices on the lunar theory, both theoretical and numerical. The work on lunar parallax includes an entire revision of the equations from which the parallax is deduced in the tables of Burckhardt and Damoiseau, as well as in the theories of Plana and Pontécoulant. Henderson had found a difference of $1''\cdot3$ in the value of the mean parallax deduced from observation, according as he employed the tables of Damoiseau or Burckhardt. Clausen had also called attention to discrepancies in the equations of parallax between the same two authorities, but had not pursued the subject, probably on account of the labour involved. But Adams not only instituted a rigorous comparison between the coefficients employed, and traced the errors of Burckhardt to their source, but added a table of corrections to the daily values of the parallax given in the Nautical Almanac from 1840–1855. This heavy piece of work, demanding as much nicety in its mathematical investigation as patience in its numerical application, Dr. Glaisher describes as characteristic of the author. No part of the work is given; the method of procedure is briefly sketched, and the final conclusions are stated in the fewest words, and simplest manner possible.

The discussion of the secular acceleration of the moon's mean motion is known almost as well as the history of the discovery of Neptune. Fierce controversy has centred round this question, and forced it on public notice. It is difficult to understand now, and impossible to explain briefly, the reason for the controversy called forth by Adams's paper in 1853. This somewhat acrimonious debate was carried on with undiminished force for some years, though Adams took little part in it beyond practically settling the fray in 1860. To Adams, and to mathematicians of the present day, the problem is purely one of dynamics. Given that the eccentricity of the earth's orbit changes at a slow uniform rate, to determine the corresponding rate of change in the mean motion of the moon. The solution of this problem is, as Adams pointed out, to be effected by means of a purely algebraical process, the validity of each step of which, admits of being placed beyond all possible doubt. Here there would seem to be no room for dispute. But the question did not present itself quite in this simple manner to Laplace and others of his time. They always had before them the necessity of explaining on purely gravitational grounds the observed motion of the moon. The complete vindication of the Newtonian theory was dear to the hearts of the schoolmen of the last century. Many triumphs had been successively won by investigations undertaken with this object, the greatest of which was due to Laplace, who was believed to have satisfactorily explained and laid to rest the last difficulty, revealed by the complicated motion of the moon. In his paper of 1853, Adams joined issue with Laplace, and in showing that the work of the earlier astronomer was incomplete, he not only destroyed the harmony that was so long supposed to exist between observation and theory, but practically impeached the judgment of those who upheld the authority of Laplace. M. de Pontécoulant seems to have urged, as a reason for the non-acceptance of Adams's value, the fact that it had "l'inconvénient d'altérer profondément l'expression analytique admise jusqu'à present, au coefficient de cette equation."

It is curious to reflect on what slender grounds the observed value of $10''$ assigned to the secular acceleration was based, and, consequently, how little increased weight it could add to any theoretical value with which it chanced to accord. We may take Dunthorne's investigation as typical of the others made with the same purpose. He computed from the lunar tables in use in his time, probably those published in 1739, and in which the moon's centennial mean motion would have a considerable error, the circumstances of the eclipses recorded by Tycho Brahe, by Regiomontanus (1478–1490), by Ebn Jounis (977–8), the eclipse of Theon (364), and those of Ptolemy. Not one of these sources is unobjectionable, or possesses the necessary accuracy. Ptolemy's catalogue of eclipses was probably selected by him to satisfy a preconceived theory. Theon says that he computed the time of the beginning of the eclipse, and found the observation agreed with his calculation. This agreement is suspicious. The Arabian observations, eye determinations of the beginning and end of the phenomena, are the best suited to the purpose; though here the error in the moon's mean longitude must be considerable, and a secular acceleration of $7''$ will satisfy the observations. Those of Regiomontanus and Tycho Brahe, still made without a telescope, must have approximately the same error, and are too near in point of time to gain the advantage of accumulation.

It is scarcely necessary now to point out the source of the error in Laplace's theory. In this error he was followed by Damoiseau and Plana, who, while extending the method to include the square and higher powers of the disturbing force, failed to detect the incompleteness of the reasoning which vitiated the earlier portion of the work. Laplace only took into account directly the radial component of the disturbing action of the sun.

This neglect of the tangential disturbing force, or the assumption that the area described in a given time by

the moon about the earth undergoes no permanent alteration, introduced a considerable error in the coefficient of m^4 in the expression for the true longitude. Correcting the whole of the coefficients in the expansion as far as m^7, Adams assigned a value to the secular acceleration that has not been sensibly disturbed by any subsequent investigation. This value is 5"·7, a quantity only about one-half of that assigned by Laplace, or of that which seemed to be demanded by observation. The minuteness of the quantity sought affords a good illustration of the powers of analysis. The acceleration of the moon's motion implies, of course, an approach to the earth, but the amount is less than one inch per annum, and this minute quantity is determined by theory to within about one-thousandth part of its true amount.

Such an investigation as this last, exhibits the patient examination which Adams was prepared to give to a term, the value of which has been frequently under review by methods that have long been pursued. It shows a confident reliance upon the accuracy of his judgment, the completeness of his work, and a refusal to be led by authority. But some later papers on the general method of treating the lunar theory will be better appreciated, as showing, perhaps, greater originality, and illustrating the application of the results of more modern mathematical inquiry to obtain greater accuracy with less expenditure of labour. It is curious to notice that but for a lucky accident, this peculiar method of treating the lunar motion, and which is likely to be much developed in the future, would not have been published by Adams himself. In 1877, Mr. Hill published his inquiry into the motion of the moon's perigee, in which is sought an absolutely accurate value of that part of c (the ratio of the synodic to the anomalistic months) which depends upon m alone. This is the historic problem that Clairaut successfully solved by adding the term depending upon m^3, and thus supplying a confirmation of the Newtonian theory when it was most needed. Delaunay has since determined the numerical value of the series as far as m^9, and possibly human patience could get little further by this process. Mr. Hill had recourse to quite a different method, which, as applied, gives the same accuracy that would be attained by carrying the series to m^{27}. The sight of this paper by Mr. Hill, seems to have reminded Prof. Adams that some ten years previously he had been at work on similar lines in order to arrive at an accurate value of g, which is related to the motion of the node in the same way that c is to the perigee. The differential equation which determines z, the moon's coordinate perpendicular to the ecliptic, is

$$\frac{d^2z}{dt^2} + \left(\frac{\mu}{r^3} + \frac{\mu'}{r_1^3}\right)z = 0.$$

Prof. Adams puts

$$\frac{\mu}{r^3} + \frac{\mu'}{r_1^3} = (n - n')^2\{q^2 + 2q_1 \cos 2(n - n')t + 2q_2 \cos 4(n - n')t + 2q_3 \cos 6(n - n')t + \&c.\},$$

and on solving this equation was led to the form that Mr. Hill had employed in his work. For Mr. Hill had made the general equations of motion depend upon a single differential equation having the form

$$\frac{d^2w}{d\tau^2} + \Theta w = 0,$$

where τ denotes the mean angular distance between the sun and moon, and Θ can be developed in a periodic series of the form

$$\Theta_0 + \Theta_1 \cos 2\tau + \Theta_2 \cos 4\tau + \&c.,$$

leading to the same infinite determinant in both cases. This is developed in a series of powers and products of small quantities, the coefficient of each term being given in a finite form. The similarity of method pursued independently by the two mathematicians, and the greater accuracy obtainable with less labour, seem to point to a new departure in the method of treating the lunar theory. Prof. Adams has indicated what appears to him the most advantageous method of treating this problem.

We can but barely mention one other of Adams's investigations, the discussion of the orbit of the November meteors. It is well known that the late Prof. Newton left undecided the periodic time in which the meteors revolved about the sun, indicating, however, the method which might lead to the settlement of the question by the discussion of the observed amount of secular perturbation of the node. By a method given by Gauss in his "Determinatio Attractionis," it is shown how to determine the attraction of an elliptic ring, such as the meteors form, on a point in any given position. By dividing the orbit of the meteors into a number of small portions, and summing up the changes corresponding to these portions, Adams found the total secular changes of the elements produced in each of the five possible periods that Prof. Newton showed might be assigned as the meteoric path. With only one of these periods, that of about thirty-three years, was it possible for the node to advance in the manner required by the several historical accounts of the meteoric display. With a thirty-three years' period, and with no other, the longitude of the node is increased 20' by the action of Jupiter, 7' by that of Saturn, and 1' by Uranus, thus 28' in all, giving a mean annual motion of 52", agreeing with the observed motion, and thus satisfactorily settling the periodic time in which the November meteors revolve.

Several other papers possess great interest, and evidence among other things much painstaking arithmetic. Such is the calculation of thirty-one of Bernoulli's numbers, and the computation of the Eulerian constant to 263 places of decimals. These may have been the occupation of his leisure moments. The reputation of Adams will ever rest upon the determination of the inverse perturbations of Uranus, the work on the lunar theory, and his inquiry into the period of the November meteors.

A CYCLOPÆDIA OF BIOLOGICAL THEORY.

Les Théories sur l'Hérédité et les grands problèmes de la Biologie générale. Par Yves Delages, Professeur à la Sorbonne. Pp. xiv + 878. (Paris: Reinwald, 1895.)

PROFESSOR DELAGES has produced in this large volume of 880 pp. royal octavo, a valuable exposition and critical discussion of the modern theories bearing upon the great problems of biology. The work is remarkable for the ability with which so vast a variety of theories and observations are epitomised and considered. Whilst the author does not profess to give

more than an outline of the chief doctrines concerned, it is the fact that there is no treatise in English or German which contains so useful a review of biological theory. Written as it is, with a patriotic motive—namely, that of inducing the rising generation of French zoologists to occupy themselves with the general theories (such as those of Darwin, Wallace, Weismann, Spencer, Naegeli, and others) which have, as he justly states, received far more attention in this country and in Germany than in France—the book should prove of very great value also to English students. This is sufficient excuse for now drawing attention to Prof. Delages' volume, although it was published more than a year and a half ago. So far as I am aware, it is not so widely known in this country as it should be on account of its comprehensive and thoroughly interesting character.

It is true that the preface to his work has caused some disagreement among the Professor's own colleagues. M. Delages in severe terms expresses his disapproval of the old school of zoological and botanical studies. He points out (and I think justly) that whilst French men of science have taken a leading part in the development of biological doctrine and methods of study during the century, yet that there has been during the past twenty years in France a tendency to "une fausse direction des recherches biologiques." For works or memoirs of importance bearing upon the great problems of general biology, there are, says M. Delages, for every one written in French, three in English and ten in German. He attributes this to the fact that French students have not had their attention sufficiently directed to these great problems. Accordingly, by a very remarkable effort, he has produced the present work which shall (and in my opinion does) serve as a cyclopædia of biological theory, by aid of which the French student may be introduced to this hitherto neglected field, and led to study for himself original authorities. In fact Professor Delages has, first of all by diligent study, corrected for himself what he regards as the defect in the current education of a French zoologist, and then has embodied his valuable abstracts and critical notes in the volume which he offers to the young men who come after him.

In spite of the fact that there are others in France who have recognised, as does M. Delages, the importance of modern theories in biology as stimulating and directly producing new observations, and thus building up the fabric of biological science, yet, on the whole, I am convinced that M. Delages is right, and that such a book as his was needed and will be very fruitful in France. It is so good a book that it will be of great service also in England.

It is true that M. Delages seems to have forgotten for a moment, in speaking of the growth of histological technique as foreign to France, that Ranvier, of the Collège de France, is one of the most original and fertile discoverers in this field at present living. It is also true that his colleague, Prof. Alfred Giard, who is surrounded by an enthusiastic band of disciples, has for many years taken actually the same attitude as that adopted by Prof. Delages, and has proclaimed the importance of the new theories, and insisted, not only by precept, but by example, on the necessity of carrying on observation and experiment in zoology in order to test hypothesis, and to determine the truth or error of current theory, rather than let them take the form of exact but meaningless record of facts, pointing to no general conclusion. None the less, it seems to me that Prof. Delages' contention is true, and that, in spite of brilliant exceptions, biological science has too often followed a false direction in France (and no doubt in England also), owing to an ignoring of the great search-lights of theory which happen to have originated outside France. The tendency to which Prof. Delages alludes was sufficiently obvious to those who were able to watch, as many still alive did, the reception of Darwin's theory of the origin of species by natural selection in France, on the one hand, and in Germany on the other. There can be no doubt that the publication of M. Delages' book is evidence of the fact that what may be called "modern biological theories" are now receiving due attention in France, and that the brilliant originality and independence of thought, as well as honesty and ingenuity of observation which characterise French men of science, will more and more be directed to the solution of those great problems which occupy the attention of the biological world at large.

A brief sketch of the contents of Prof. Delages' book is all that the space of this article permits me to give. It is divided into four parts: Part i. The Facts; Part ii. Special Theories; Part iii. General Theories; Part iv. The Theory of Actual Causes. Under Part i. are treated (1) *The Cell:* its constitution, its physiology, its reproduction; an admirable *résumé* in ninety pages of the recent work, both on karyokinesis and the physiology of protoplasm. (2) *The Individual:* regeneration, grafting, generation, ontogeny, alternation of generations, sex and secondary sexual characters, latent characters, teratogeny, correlation, death and continuity of life, the germ-plasma. (3) *The Race:* heredity, variation, the formation of species. Under Part ii. we find statements of the following theories. (1) Speculative theories as to the structure of protoplasm and the cause of its movements, viz. the theories of Berthelot, of Verworn, of Quincke, and of Butschli; (2) theories of cell-division; (3) theories of regeneration; (4) of polar globules; (5) of sexual generation; (6) of the ontogenetic process; (7) of the parallelism of ontogeny and phylogeny; (8) of the origin of sex; (9) of teratogeny; (10) of death and of germ-plasma; (11) of heredity; (12) of the transmission of acquired characters; (13) of latent characters; (14) of telegony; (15) of hybridity; (16) of variation; (17) of the formation of species.

Under Part iii. we have statements and brief, but trenchant, criticism of the theories of "animism," "evolutionism" (spermatists and ovists), and "micromerism." Under the last term are included and considered the views of Buffon, Béchamp, H. Spencer, Haacke, Dolbear, Erlsberg, Haeckel, His, Cope, Orr and Maulia, and many others, including that of "ancestral plasmas" (Weismann), pangenesis (Darwin), stirpes (Galton), whilst "organicism" is the term applied to the theory of Descartes and to the auto-determination of Roux.

In the fourth and last Part are given "Idées de l'auteur," a retrospect and review of much of what has been already treated at greater length, with the definite introduction of the author's own conclusions. By this method of division

of his work, Prof. Delages has very successfully made clear to his reader the facts under consideration, the theories which have been advanced in relation to those facts, and finally his own judgment as to what is sound and permanent and what erroneous in current theories; whilst those theoretical views which are novel, and here put forward for the first time by himself, are kept distinct. A bibliographical index, of eighteen closely-printed pages, completes the work; and with regard to this long and useful list of books and memoirs, I may say that the impression given to a reader of M. Delages' book is that he has not merely cited the titles of this large mass of literature, but has actually performed the heavy task of reading and critically estimating each work thus catalogued.

It is, of course, inevitable that such a task as that undertaken by the author should not be accomplished without some omissions and some mistakes; but it is no little merit to have performed such a task conscientiously, as it has here been performed. The criticisms advanced by M. Delages may not always be those which commend themselves to another biologist; his own theoretical views, though always philosophical and worthy of full attention, may not be necessarily acceptable in every case. Yet the value of the work is not lessened by such considerations. He is no dogmatist, and candidly declares that the theories, which he for the present accepts, are open to correction and replacement with the progress of knowledge. The worthy and useful object of the book is, in short, not to impose a set of theories on the reader's mind, but to interest him in the theoretical aspects of biological phenomena, and to assist him, as far as may be, in arriving at theoretical conceptions which may guide his investigations, if he be a naturalist, or furnish him with a key to the more popular discussions of biological problems, should he be merely a philosopher, or even "un homme curieux des choses de la science." It is a book which should be read and closely studied by every young biologist. The full and comprehensive treatment of the subject has resulted in what must appear a formidable volume equivalent to some three or four modern manuals; yet the reading of it will be found to entail but little effort, on account of the lucidity of the author's method and the unflagging interest which he himself evinces in the successive sections of his work. It is, after all, a distinct pleasure to see English and German theories formulated in the clear logical phrases of the French language.

E. RAY LANKESTER.

COMPARATIVE MYTHOLOGY.

Contributions to the Science of Mythology. By F. Max Müller. Vol. i. Pp. xxxvi + 426. Vol. ii. Pp. ix + 427–864. (London: Longmans, 1897.)

IT has for some time past been tolerably well known by many that Prof. Max Müller was working at a treatise on comparative mythology, and with others we have been anxiously awaiting the appearance of the "last word" on the subject by the eminent Oxford professor. General interest in the matter has, moreover, been excited to a more than usual extent by the comments made upon the last edition of "Chips from a German Workshop" by writers for the press and others, for all felt that the veteran expounder of dead and gone beliefs would rise in his might and rend certain of his critics who boldly stated that he stood alone, and was the only defender of a set of dying and dead theories. It seems that Prof. Max Müller hesitated for some time before he decided to publish the 864 octavo pages which form his present work, for he had almost made up his mind that he had arrived at a time of life when rest is more pleasant than work, and at a stage in his work where it was wise to stop and let the younger men carry it on in his place. Every reader of the volumes before us will be glad that the taunts of his enemies stung Prof. Max Müller into action, for, as he says, he had all along intended that his last work on comparative mythology should contain in a comprehensive form what he had hitherto written, and what he still wished to say, and he intended it to be the logical ending of a system of works which he had planned several years ago. On Language, Religion, and Thought he has already written learnedly and charmingly, and now that we have the volumes on the fourth subject, viz. Comparative Mythology, the system which Prof. Max Müller has elaborated is before us in its entirety. Those who seek for polemics or hostile observations upon critics and their rival theories will be disappointed in the perusal of this last section of the work, for he confines himself chiefly to re-stating his views and theories, and it is pretty clear that he has made up his mind to differ from his critics on fundamental principles and methods.

Prof. Max Müller quotes many great names in support of his views, and the general reader will find it very difficult to make up his mind which school he is to follow—the linguistic or the anthropological. The anthropological school holds that mythology is, on the whole, the narrative of the various grades through which the human race has advanced slowly towards what we call civilisation, and it proves many of its statements by drawing comparisions between the beliefs, manners and customs, and habits of savages which still exist on the earth, and those of the nations which have long since passed away.

Prof. Max Müller holds that mythology is the result of a period of moral decay, and a falling away from high moral and spiritual views; we must admit that our sympathies lie with the anthropological school, and we heartily wish that Prof. Max Müller had seriously set to work to classify and arrange the arguments which have been brought in line against him, and also that he had disproved many of the statements and facts alleged against his views. Some, too, will complain that little notice has been taken by him of the writings of men who, though they be his adversaries, are held in esteem by many thoughtful and intelligent people. With the details of the minor differences between the schools we have nothing to do, for, after all, they are only interesting to the experts themselves; we hear that Mr. Lang is about to write a refutation of the most recent expression of Prof. Max Müller's views, and we may be tolerably certain that the *minutiæ* of the subject will not be passed over.

It is but just to call attention to the great learning and skill with which Prof. Max Müller has arranged his

information, and the careful student will find scores of facts stated quite simply, and without any attempt to impress the reader, which could be found in no other book in the English language. Whether Prof. Max Müller be all right or all wrong, it must never be forgotten that he is a great linguist as well as an expounder of mythology, and that if some of us hold views other than his, we ought not to belittle the labours of the hard-working scholar who has done so much to explain to two generations of men the lessons which language has to teach. To write easily, accurately, and pleasantly of a difficult subject is a gift which is worth a great deal.

OUR BOOK SHELF.

The Story of the Earth's Atmosphere. By Douglas Archibald, M.A., Fellow and some time Vice-President of the Royal Meteorological Society. Pp. 208. (London: George Newnes, Ltd., 1897.)

THIS is one of the best of the Story series that we have read, but will probably not prove itself one of the most popular. If this prognostication prove correct, it will be because a large part of the public prefers to be amused rather than instructed. The author has endeavoured to compress too much information within the small compass at his command, and this design has in some measure destroyed the ease with which such a book should be read. The mechanics of the earth's atmosphere is not an easy subject for popular treatment, and though we cannot regret that the attempt has been made to give wider publicity to the work of Ferrel, Helmholtz, and Von Bezold, we cannot help feeling that the result would have been more satisfactory if the author could have given more space to his work, or had ventured to fill a larger canvas. The tale, on the whole, is pleasantly told, and the author is frequently able, from his wide travels, to illustrate his remarks by his own personal experience in climates where meteorological manifestations can be witnessed on a grander scale than in our own country.

Starting with the nature and chemical composition of the atmosphere, the author treats of the circumstances that affect its varying temperature. In this section some of the diagrams might have been a little clearer and a little more finished. The reference letters are in some cases barely legible. We notice, too, a curious sentence on page 52, which will puzzle the student: "As a general rule we find the greatest ranges of temperature of the lowest atmospheric stratum between day and night occur in the driest parts of the earth . . . where it often amounts to 40° F., and the smallest ranges in small oceanic islands, where it is as small as 50° F." From the remarks on temperature the author proceeds to discuss the winds and general circulation of the atmosphere, but the description of the more local phenomena of cyclones is deferred till after the consideration of precipitation. Some little improvement would, we think, result from a different arrangement of the chapters, which would not only have brought the same class of phenomena more closely together, but might have prevented the partial repetition of some of the facts contained in the earlier chapters. For example, two chapters on the sounds and colours of the atmosphere separate the one on cyclones from that relating to whirlwinds, tornadoes, &c., while the few remarks on dust and disease, in the last chapter, could possibly have found adequate expression in some of the others. But we willingly admit that Mr. Archibald had a very difficult task, and has accomplished it with a great measure of success. He was not willing to give a bare statement of facts, but has everywhere attempted to add an explanation of them. The book is written right up to date; and though some of the explanations may require modification as the study and science of meteorology advance, this is no impeachment of their present value, nor does it imply any fault on the part of the author.

W. E. P.

Wild Bird Protection and Nesting-Boxes, &c. By J. R. B. Masefield. 12mo, pp. 129. Illustrated. (Leeds: Taylor Brothers, 1897.)

ALL interested in the preservation of the feathered denizens of our woods, heaths, streams, and lakes (and who is not?), will give a hearty welcome to this useful, although unpretentious, little volume, which seems evidently the work of one well acquainted with his subject. After a short introduction, in which the author tells us that he has induced no less than six-and-thirty species to nest in his own garden, the book is divided into four chapters. The first deals with modern legislation on bird preservation, and the powers which a County Council can acquire for the purpose. In the second, we have a brief account of mediæval laws for the protection of those birds which were becoming scarce in early times. The third, and most generally interesting chapter, gives the author's experiences as to the best mode of attracting different kinds of birds to build; and the contrivances, which he describes so well and figures so admirably, will be found worthy of the best attention of those who may be inclined to devote their spare hours to this pursuit. In the fourth and final chapter, we find lists of the various species scheduled for special protection by different County Councils. From this we are glad to see that a very large percentage of these authorities have taken up the matter in good earnest. If a suggestion may be offered, it would seem preferable, in cases where a large number of species are scheduled, to include all the smaller birds, as otherwise none but a professed ornithologist can determine whether the order has been infringed. R. L.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by J. Batty Tuke, M.D., and D. Noël Paton, M.D. Vol. vi. Pp. 303. (Edinburgh: William F. Clay, 1897.)

A DESCRIPTION of the new laboratory of the Royal College of Physicians, Edinburgh, and a retrospect of the work done in the old laboratory, forms an introduction to this volume. The papers refer to investigations in anatomy, physiology, pathology, and pharmacology. Many of them are of too special a character to be usefully mentioned here, but among the subjects dealt with are: the relationship of the liver to fats, the action of large doses of dilute mineral acids on metabolism, acid and alkali albumin, influence of thyroid feeding on the proteid metabolism in man, the amount of iron in ordinary dietaries and in some articles of food, analyses of iron in the liver and spleen in various diseases affecting the blood, *Catha edulis*—a plant grown in parts of Arabia and Eastern Africa and widely used as a mild stimulant, carbonic acid gases in diseases of the alimentary tract (this paper brings out some interesting points as to the influence of carbonic acid gas upon digestion), and the Malayan arrow poisons.

First Principles of Natural Philosophy. By A. E. Dolbear. Pp. x + 318. (London: Ginn and Co., 1897.)

THIS elementary book is intended for those who wish to obtain some knowledge concerning the more generally recognised problems and principles pertaining to physics. With this object in view, the author has restricted himself to a simple exposition of the subject, and, with the further help of numerous illustrations and worked-out examples, the reader is made acquainted with the fundamental laws and principles relating to heat, optics, electricity, magnetism, &c. The mathematical treatment of the subject is, for the most part, laid on one side, only that of the most elementary character being attempted. The beginner, however, should get a fair insight into the subject if he uses this book as a first step to a more elaborate treatise, and in this respect it should find many readers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Adjustable X-Ray Tubes.

THE writer has discovered a method of adjustment for X-ray tubes, somewhat different to those he has previously described, which possesses distinct practical advantages.

The arrangement is as shown in the illustration, and its essential feature consists in mounting the kathode upon a sliding support, so that it can be moved axially to a very small extent in and out of a tubular neck, blown on one end of a glass bulb. When arranged in this manner, the exact position of the kathode is found to have an enormous influence upon the penetrative value of the X-rays produced. With a suitable and constant degree of exhaustion, if the kathode is placed as shown in full lines in Fig. 1, X-rays of very high penetrative value are produced, while the small movement of about ·3 inch required to place it in the position indicated by the dotted lines, will suffice to reduce the penetrative value of the rays almost to nothing. Between these two extremes every grade of penetrative value is readily obtained by simply altering the position of the kathode between its limits of travel. If the tube be used in a horizontal position, this can easily be done by merely tapping it at one end or the other, without removing it from its support, and the anti-kathode being a fixture, the point of origin of the X-rays remains always in the same position. In this manner, with a single tube, and without alteration to the vacuum, X-rays of any desired penetrative value can readily be obtained, while at the same time it is possible to compensate for the uncontrollable variations in vacuum that are found to occur in practice, and thus to maintain the penetrative value of the rays at any desired degree.

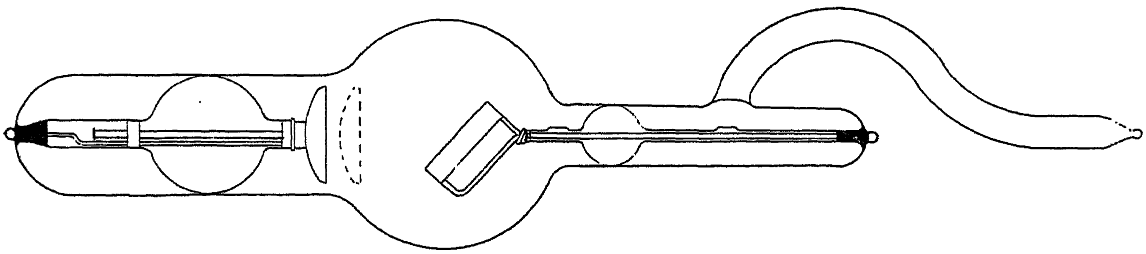


FIG. 1.

The effect is evidently due to changes in the electrical resistance of the tube, which, as measured by the alternative spark in air, is much highest when the kathode is in the position shown in full lines, *i.e.* that which gives rays of the greatest penetration, and appears to be closely connected with the proximity of the kathode to the glass, which is greatest in the position just mentioned.

This factor is evidently so important that it much more than neutralises the effect of the alteration to the distance between kathode and anti-kathode, which, as the writer has previously shown, has the result of increasing the penetrative value of the rays, and also the resistance of the tube, the nearer these two electrodes are together.

In order to obviate the overheating of the anti-kathode, which is a considerable source of trouble in all X-ray tubes when much electrical power is employed, the writer finds it convenient to mount the ordinary small disc of platinum upon a considerably larger and thicker disc of aluminium, say about 1 inch in diameter and ·25 inch in thickness, the platinum being tightly wedged and riveted in a shallow circular depression turned out of one face of the aluminium disc. Owing to the considerable radiating surface of the aluminium, and its considerable mass, this arrangement prevents the platinum from attaining an excessive temperature. In addition, the platinum having only one surface exposed, the tubes do not blacken so quickly.

May 17. A. A. C. SWINTON.

Boomerangs without Twist.

IN your issue of May 13 (p. 46), a writer mentions some Australasian boomerangs as thrown *not to return* (if I have rightly understood him). I had not heard of these before, but in British India at least one race, the Kolis of Northern Gujarat, have the like. These are invariably of "fish" section, varying in weight, curve, and material; but the commonest and most efficient sort is of "Babul" wood (*Acacia arabica*), with the natural curve of the heart of the wood, something like that of an old-fashioned genuine Turkish sabre, rather a "knee" than any regular geometric curve.

They are used with great effect on ground-game; much less, of course, on birds. In one case an old and feeble man, threatened by a swordsman, cut the assailant's shins across with his boomerang at about ten paces, and *brought him down*. Before the astonished thief could rise, the now unarmed old man had disarmed and literally taken him captive.

I tried the case myself, gave the swordsman two years, and the boomerang man much honour. Certain people called *Maravars*, in the south of the Madras Presidency, are said to have similar boomerangs; but I have not seen them.

Many Indian races throw straight sticks at game habitually, and even in a city riot the thrown sticks are often more dangerous than those in hand (bar iron-bound clubs). But their practice is not scientific, like boomerang-throwing.

W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, S.W., May 14.

Scorpion carrying Flower.

ONE evening last February, while sitting in the verandah of my house at Aden, my attention was drawn to an object advancing across the floor, which seemed to be some peculiar leaf insect or phasma. On looking at it closer I saw it to be a scorpion (identified by Mr. Pocock from my description as *Parabuthus liosoma*), which was holding over its back by one claw a large blossom of *Poinciana regia*, known in Aden as the white-gold mohur tree. Its tail, curled over its back, further assisted in retaining the flower in position. The nearest tree from which it could have obtained it was at least 30 feet away, and to bring it the scorpion must have carried it over a low stone parapet and up two or three steps, so that intention seems to be proved. What that intention was it is hard to define. Hardly for concealment, for the size of the flower made it more conspicuous; besides, it was night. If it was the lamp-light it wanted to avoid, it is necessary to assume that, finding the light too strong, it went back to get the flower. It could hardly be as food, for scorpions are not known to live on vegetable substances; nor, as far as I know, do they construct nests. I regret that I did not allow the creature to reach its destination, and so ascertain its intention; but, unfortunately, I gave in to my first impulse and crushed it. My wife suggested that perhaps it was going to a wedding, but this explanation is more poetical than scientific.

Some of your readers may be able to throw a little light on this curious instance; but Mr. Pocock, of the British Museum, to whom I related the above, said he had never heard of a similar case.

A. NEWNHAM.

The Utility of Specific Characters.

MR. COCKERELL asks whether it is possible to explain right-handedness, the dextral or sinistral coil of snail-shells, and similar features as having any utility to the species, and he then speaks of

the advantages of uniformity. In the case of right-handedness it is obvious that these advantages must be great, as various tools and machines are made in conformity with the fact that nearly all persons use their hands alike; screws, for instance, having to be driven in by the rotation outward of the right hand. A left-handed man would naturally turn his wrist outwards to the left, and therefore the driving of an ordinary screw by turning the hand inward would be difficult and awkward.

In any community where there existed some left-handed men, and a building had to be erected, they would be found to be inferior workmen, and remain behind in the struggle for existence.

I understand Mr. Cockerell to say that in the case of spiral shells there may be natural environments tending to favour uniformity of shape and prolonged existence, just as in man these environments are artificial, but at the same time beneficial and tending to the same end. SAMUEL WILKS.

Grosvenor-street, May 19.

Luminous Phenomena observed on Mountains.

CONCERNING the letter of Mr. C. G. Cash, on "luminous phenomena observed on mountains," in your number of May 13 (p. 31), I do not doubt you will be informed by many readers of NATURE that they are evidently, and undoubtedly, due to St. Elmo's fire. J. M. PERNTER.

Innsbruck, University Observatory, May 21.

The Effect of Wind and Atmospheric Pressure on the Tides.

THE problem of the effect of wind and atmospheric pressure on the tides has received repeated and considerable attention from scientific as well as from practical men. Especially for the latter, *e.g.* sea captains and pilots, an acquaintance with the effects produced is of considerable importance.

The efforts and the money which all civilised nations employ in obtaining good tide-tables, prove that these are of utmost usefulness and value to navigation; and we need not be astonished at this, when we think of the necessity of a swift and safe course, especially in international trade.

The calculations of the tides in the tide-tables are principally based on astronomical influences; they indicate time and height of the tide, which may be expected from the relative position of sun, moon and earth, and generally refer to normal meteorological conditions.

In reality, those conditions differ from the normal state. Wind and atmospheric pressure are continually changing, and cause the time and the height of tide to vary in different degrees from the normal value indicated in the tide-tables.

Navigation has an interest in exact tide-tables, and, in the same way, the pilots and sea captains wish to be able to calculate the extent to which the depth of the water will be affected by meteorological influences, because it may depend on these, if it will be possible to cross a bar or shoal in a tidal river, or enter into the mouth of a tidal harbour.

So far there does not exist a formula, which allows the calculation of the correction to add to the data of the tide-tables, if the force and direction of wind and the indication of the barometer are known.

While in Germany considerable attention to the effect of wind on the tides has been paid by Hugo Lentz, Prof. Möller, Prof. Bübendey, and others, French scientific men have principally given their attention to the effect of atmospheric pressure. In the "Annuaire des marées des Côtes de France" a table is to be found, according to which a rise of one millimetre in the barometer causes a depression of the tide of 13 millimetres. The same correction can be used for all the harbours, and the seamen are advised to apply this correction. It can, however, be neglected for barometrical indications lower than the mean position, viz. 760 millimetres.

A civil engineer, E. Engelenburg, tried to calculate separately the effects of wind and atmospheric pressure for Flushing, in his article published in *De Ingenieur* (a Dutch weekly paper), No. 39, 1891. Unfortunately the records he used were not sufficient to afford a definite solution of the problem. Nevertheless, his study remains a very interesting addition to the literature on this subject.

All these investigations, however, have not led to any suitable formula by which the corrections for wind and pressure might be calculated. No wonder, therefore, that in England, the navigation-country *par excellence*, particular consideration has been paid to the said subject.

Many elaborate investigations thereon have been made by Mr. W. H. Wheeler, of Boston, who communicated the results of his study at the meeting of the British Association at Ipswich, in 1895.

Mr. Wheeler's address gave rise to the appointment of a Committee, consisting of Prof. Vernon-Harcourt, Prof. Unwin, Mr. Deacon, and Mr. Wheeler (Secretary), in order to investigate this subject, especially for the practical purpose of ascertaining whether the records of the wind and atmospheric pressure, as obtained by an observer at any particular port, might afford a trustworthy guide to pilots and mariners as to the variations to be expected in the height of the tides, from those ascertained by calculations and given in the tide-tables.

Information was asked from authorities of all the principal ports in Great Britain, and also from the Hydrographic Departments of the principal maritime ports in other countries.

The tidal records of five English ports, viz. Liverpool, Sheerness, Portsmouth, Hull and Boston, were selected for a careful examination. The results of these investigations have been presented in a report of the said Committee, drawn up by the Secretary.

In general the results obtained, both those relating to the effect of atmospheric pressure and those relating to the effect of wind, are not very satisfactory.

Nevertheless, the summary of the report contains a useful table giving the increase or decrease of tide for different forces of wind (3° to 10° Beaufort scale) per foot rise of tide.

The reason why the results are so little satisfactory, seems to me due to the method of investigation employed.

In analysing the effects of atmospheric pressure, a mistake was made by not sufficiently eliminating the effect of the wind. The latter being predominant, the effect of pressure could not be made clearly visible. Concerning the effect of wind, the principal cause of failure, I believe, is to be found in an erroneous working hypothesis, and in a wrong consideration of the influence of wind on the sea-level.

The hypothesis was, that wind blowing in the direction of the tide increases the range of tide; the high water being raised and the ebb being lowered, whilst wind blowing in a direction opposite to the tide has the contrary effect.

Considered from that standpoint the observations were separated according to the circumstance, whether the wind was blowing in the direction of the tide or contrary to it; and the results were drawn up in such a way as to show the amount of the raising or depressing of the tide, caused by the same force of wind at different ports, proportional to the mean rise of tide at those ports.

These considerations are contrary to the facts mentioned in Hugo Lentz's work, and also to the observations of the Dutch engineers on the coasts of Holland.

Those facts and observations show everywhere, that high and low water both are raised or depressed by wind, so that the range of tide is not considerably affected. They also show that the raising or depressing are not dependent on the range of tide, but depend to a great extent on the form of the coast-line, and especially on the depth of water; the effect increasing when the water is shallow.

Another point of difference is, that the most important influence is not felt when the wind is blowing in, or opposite to, the direction of the tide—as was supposed by the Committee—but, on the contrary, when the wind is blowing at right angles to the coast-line, *e.g.* perpendicular to the direction of the tide.

Hence the arrangement of the observations in the way adopted by the Committee could not but have the result that the raising and depressing of the tides partially neutralised each other.

The reasons just mentioned cause the table, according to which the variations due to wind is given per foot rise of tide, to be erroneous in principle, because the variation caused by wind is not proportional to the range of tide.

Trustworthy results can only be obtained if exact tide-tables are at our disposal; if the calculated data are compared with the observations, and the variations are arranged according to the simultaneous direction and force of the wind, and the atmospheric pressure; and last, not least, if the results are carefully arranged in such a way that each effect comes forth unaffected by the other. This principle is applied to the height and to the time of the tide on the Holland coast.

In order to get a thorough check, the calculations are made independent of each other for five series of observations as to the height, and for three series as to the time of the tide. A comparison of the results will show what degree of exactness can be obtained, and how far the obtained results can be trusted.

The said series contain—

I. (1) The height of high water at Ymuiden in 1895
(2) ,, ,, ,, ,, 1896
(3) ,, low ,, ,, 1895
(4) ,, ,, ,, ,, 1896
(5) ,, high ,, Hoek van Holland 1896

and

II. (1) The time of high water at Ymuiden in 1895
(2) ,, ,, ,, 1896
(3) ,, ,, Hoek van Holland 1896

The importance of checking is further increased because of the different methods of wind-observation.

At Hoek van Holland the indications of a self-registering apparatus were used, which gave the force in kilogrammes (kg.) per square metre. (1 kg. per square metre) = 0·205 lb. per square foot.)

At Ymuiden the direction and force were noted at 8 a.m. and 4 p.m.; the force was estimated by a scale of 6 degrees, the signification of these being as follows:—

Ymuiden scale	Signification	Equal to: Degrees of Beaufort scale	Pressure in kg. per square metre	Velocity in metres per second (1 m. = 1·09 yard = 3·28 feet).
1	Gentle breeze	1·9	4	5·7
2	Fresh ,,	3·3	9	8·5
3	Strong ,,	4·9	18	12·0
4	Gale	7·3	45	19·0
5	Heavy gale	—	—	—

The tidal observation has in each case been combined with the preceding meteorological observation; thus the latter, on an average, fell six hours before the moment of tidal observation.

This combination is not illogical. A special investigation at Hoek van Holland, concerning the question how much time a certain wind preceded its observed effect on the tide, in order to find the limits of this precedence, showed that the average effect on the height of tide followed the cause after a minimum of five hours (out of 17 observations), and a maximum of 6 hours (60 observations); and on the time of high water after a minimum of 4 hours (13 observations) and a maximum of 7 hours (33 observations).

The calculations for finding the effect of wind and atmospheric pressure have been made as follows.

The variations between observation and prediction (those for the height of tide after a proper correction concerning the annual variation of the height of half-tide) were arranged in groups. Each group contained the observations at a definite direction of the wind and a definite force; *e.g.* all the observations during N. wind and a force = 1° Ymuiden scale, were combined to a group N 1.

Considering that each group corresponds to a definite influence of wind, it is evident that the reciprocal differences of the variations, united in that one group, are caused by differences in atmospheric pressure.

A second supposition was, that the effect of atmospheric pressure in every group was proportional to the difference of the barometer from its normal value of 76 centimetres mercury.

Let, therefore, the wind-effect for a certain wind-group and normal barometer be x . . .

The rise of 1 centimetre barometric pressure corresponding to a depression of the sea-level of y centimetres . . .

The value of a variation $= v$ . . .

The observed barometric pressure $= 76 + b$ centimetres, then we have

$$x + by = v.$$

We have, therefore, in one group containing n observations, n equations with two unknown quantities x and y, out of which the values of x and y can be solved. This method has been applied to the groups containing ten or more variations.

The values of y thus calculated, with consideration of the number of the observations, served to deduce the effect of the directions of the wind on the value of y; this known, the groups containing less than ten variations were submitted to a correction according to the calculated value of y, and so the real value of x was obtained.

These values of x now served to deduce the following quantities:—

(1) The effect of absolute calm.
(2) ,, ,, the force of wind.
(3) ,, ,, the direction of wind.

As is known, the level of the sea at absolute calm differs from the mean annual level, because the latter is influenced by the prevailing winds.

In calculating the effect of wind the supposition was made, that for every direction the effect of definite forces is always expressed by the same proportion—*e.g.* the effect of a force 3 being double that of force 2; this proportion remaining the same at all directions of the wind.

The calculations made according to these principles showed that the effect of wind and atmospheric pressure on the tides can be represented by the following formula:—

$$C = (KR - a) + R_b(B - 76·0),$$

in which

C is the correction in centimetres to be applied to the predicted height of high, as well as low water.

K is a coefficient depending on the force of wind.

R is a coefficient depending on the direction of wind.

$-a$ is the correction which should be applied in the case of absolute calm (when K = 0).

R_b is a coefficient depending on the direction of wind, although relative to atmospheric pressure.

B is the atmospheric pressure in centimetres mercury.

In order to examine the results obtained by calculating the independent series of observations, I give those *in extenso*. They have reference to conditions which have, in general, similarity enough to allow the comparison, as the following results will prove.

I. Value of K.

Force of wind according to: Estimation in degrees of the Ymuiden scale	Pressure in kg. per m².	Calculated values of K at Ymuiden: High water 1895	High water 1896	Low water 1895	Low water 1896	Mean of the 4 values	Pressure of wind registered at Hoek van Holland, kg. per m².	Calculated value of K at Hoek van Holland, high water 1896
1	4	4	4	5	3	4	0	4
2	9	10	8	11	9	9·5	0–5	6
3	18	21	23	20	20	21	5–10	12
4	45	50	38	38	45	43	10–20	17
5	—	71	—	75	—	73	20–30	34
							30–50	38
							50–70	56

II. Value of R.

Direction of wind	N.	N.N.E	N.E.	E.N.E	E.	E.S.E	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W	N.N.W
High water, 1895 Ymuiden ...	0·6	−0·3	−1·2	−1·2	−1·1	−0·9	−0·4	0 2	0·6	0·7	0·8	1·1	1·4	1·5	1·3	0·9
,, 1896 Ymuiden ...	0·6	0·1	−0·7	−1·2	−1·6	−1·2	−0·4	−0·1	0·1	0·5	0·9	1·3	1·6	1·4	1·2	0·8
Low water, 1895 Ymuiden ...	0·8	0·1	−0·7	−1·0	−1·3	−1·0	−0·4	0·4	1·1	0·9	0·9	1·1	1·5	1·6	1·6	1·2
,, 1896 Ymuiden ...	0·7	0·5	0·0	−0·7	−1·4	−1·5	−1·0	−0·3	0·2	0·5	0.9	1·4	1·8	1·3	0 9	0·8
High water, 1896—Hoek van Holland	0·4	−0·3	−0·9	−1·0	−1·1	−1 4	−1·6	−0·6	0·0	0·4	0·8	1·3	1·7	1·7	1·3	0·9

III. Value of a.

High water, Ymuiden, 1895 ... $a = -3$ centimetres
,, ,, 1896 ... $a = -1$,,
Low water, Ymuiden, 1895 ... $a = -8$,,
Low water Ymuiden, 1896 ... $a = -2$ centimetres
High water Hoek van Holland... 1896 ... $a = -2$,,

IV. Value of Rb.

Direction of wind	N.	N.N.E.	N.E.	E.N.E.	E	E.S E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W	NW	N.N.W
High water, 1895 Ymuiden ...	−12	−10	−8	−8	−7	−7	−6	−6	−6	−7	−7	−8	−11	−14	−15	−14
,, 1896 Ymuiden ..	−13	−13	−10	−9	−8	−9	−10	−9	−8	−7	−7	−7	−6	−9	−15	−15
Low water, 1895 Ymuiden ...	−11	−6	−6	−6	−1	+1	−3	−7	−8	−5	−4	−5	−8	−12	−15	−14
,, 1896 Ymuiden ...	−12	−14	−11	−9	−8	−6	−5	−5	−4	−4	−4	−6	−7	−9	−12	−11
High water, 1896—Hoek van Holland	−13	−14	−15	−13	−10	−10	−12	−14	−12	−9	−9	−13	−16	−17	−12	−11

In calculating the effect of wind and atmospheric pressure on the time of high water at Ymuiden in 1895 and 1896, and at Hoek van Holland in 1896, exactly the same method has been followed.

The formula by which this effect can be expressed, is the following:—

$$C_r = KR + R_b(B - 76\cdot0).$$

C_r means the correction in minutes to be applied to the predicted time. For the rest the form of the formula is in every way equal to that for the height, except the disappearing of the term a. At absolute calm the mean time of high water, therefore, will not differ from the normal. The sign + signifies that the observed time of high water is later than the predicted, the propagation of the tide being retarded.

The following tables again give an idea of the results and the obtained degree of exactitude:—

I. Value of K.

Force of wind in degrees of the Ymuiden scale	Velocity of wind in m per second	Calculated values of K at Ymuiden: High water 1895	High water 1896	Mean value	Pressure of wind registered at Hoek van Holland, kg. per m²	Mean value	Corresponding velocity of wind in m. per second	Calculated value of K at Hoek van Holland, high water 1896
1	5·7	3	6	4^{6}	0	0	2	1
2	8·5	6	5	5^{9}	0−5	3	4·9	4·5
3	12·0	9	9	8^{8}	5−10	7	7·5	7
					10−20	14	10·6	10
					20−30	24	13·9	13
					30−50	38	17·4	20

As an explanation, it may be mentioned that the velocity of wind being v metres per second, the pressure can be represented by $k = \frac{1}{8}v^2$ (k being expressed in kg. per m²); and the pressure k being known the velocity $v = \sqrt{8k}$.

II. Value of R.

Direction of wind	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W	W.	W.N.W	N.W	N.N.W
Ymuiden, 1895	$0·4^{5}$	1·1	1·6	0·8	−0·4	−1·2	−1·1	−1·0	−1·3	−1·1	−0·9	−0·7	−0·2	0·1	0·3	$0·4^{5}$
,, 1896	1·5	1·6	1·3	0·5	−0·2	−0·7	−1·1	−1·1	−0·9	−0·7	−0·6	−0·4	−0·1	0·5	1·1	1·3
Hoek van Holland, 1896	1·4	1·6	1·1	0·6	0·0	−0·5	−0·7	−1·5	−1·8	−1·4	−1·0	−0·7	−0·5	0·1	0·5	0·9

III. Value of R_b.

Direction of wind	N.	N.N.E.	N.E.	E.N.E.	E.	E S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W	W.	W.N.W	N.W	N.N.W
Ymuiden, 1895	1	−1	0	3	4	3	4	5	4	3	3^{5}	4^{5}	7	8	6	2
,, 1896	2	2	1	3	5	6	5	4	4	6	7	6	5	3	−1	0
Hoek van Holland, 1896	−2	−3	1	3	4	5	5	6	7	7	6	5	6	7	5	2

The given data may serve to show the value of the results.

We see that the correction for the height of high water, as well as of low water, at Ymuiden and Hoek van Holland, can be expressed by one formula with a sufficient degree of exactitude for practical use.

Herewith the proof is given that the wind and atmospheric pressure do not considerably change the range of tide, but affect the high and the low water in the same way, both being raised or depressed.

The value of a at low water seems rather larger than at high water; thus on an average the absolute calm-level at low water is 5 centimetres lower than the mean low water, and at high water 2 centimetres lower than the normal. In practice this difference of 3 centimetres may fairly be neglected; for the study of the phenomena, however, they are important, because they show that the raising of the level, caused on the Holland coast by the prevailing western winds, is rather more considerable at low water than at high water. The reason of this is the greater depth of water at high water-level.

The tables show very clearly that the influence of atmospheric pressure on the height of the tides is not the same for the different directions of the wind, but is the greatest during northern winds, the feeblest during southern winds; the proportion often being much more considerable than we might expect from the proportion of the densities of mercury and sea-water.

I think it probable that in this proportional factor, the character of wind is comprehended—that is to say, that at a certain atmospheric pressure the same observed wind may be more local than at another barometric pressure; in the latter case the wind, for instance, reigning over a more considerable part of the North Sea, and thus having a greater effect on the height of the sea-level.

Very remarkable is the evident and regular influence of atmospheric pressure on the time of high water, which at first consideration one would not expect. High barometer retards the time of high water.

The values of R show clearly that the sea winds raise the level of the sea, and off-shore winds cause a depression. North and south winds act as sea winds; the neutral line lies N.N.E. and S.S.E. The greatest rise is more considerable than the greatest depression, the former being caused by W.–W.N.W. wind, the latter by E.–E.S.E. wind.

The effect of wind on the time of high water is not in phase with that on height, but differs about 90° with it.

The tables indicate that southern winds, which have the same direction as the tidal wave, advance the moment of high water, whilst northern winds retard this moment. The most important retardation is observed during N.N.E.–N.E. wind; the most important advance during southern winds; the neutral line is between E.N.E. and E. and between W. and W.N.W.

The most remarkable result, brought out with surprising clearness, seems to have the character of a general law of nature (which, however, should be affirmed with perfect evidence by comparing the obtained results with those on other points observation), and is the following:—

That the raising or depressing is proportional to the pressure of wind, and that the advance or retardation in time is proportional to the velocity of wind.

It would be highly interesting if the same kind of investigation could be applied to the English North Sea coast, in order to see whether the influence of wind, as found for the Holland coast, is local, and therefore opposite to the results to be obtained at the English side; or if the results are the same, thereby indicating the influence to dominate the whole North Sea.

A special investigation as to whether a wind, continually blowing, increases or decreases the effect on the high water-level, did not give a definite rule. In general there seemed little difference in height between the first and the second high water for the same conditions of wind.

Strong off-shore winds seem to influence the second, and, principally the third and following high water-tide less than the first; so that the long duration seems to weaken the effect of off-shore winds.

Preceding formulæ now permit us to give a formula for practical use. This formula is:

(1) For the height of high water and low water at Ymuiden and Hoek van Holland,

$$C = KR - 3 - R_b(B - 76{\cdot}0),$$

expressed in centimetres.

(2) For the time of high water at Ymuiden and Hoek van Holland,

$$C_\tau = K_\tau R_\tau + R_{b\tau}(B - 76{\cdot}0),$$

expressed in minutes.

These formulæ give, as for the sign, the correction to be applied to the height, and the time predicted in the tide-tables.

The value of the coefficients are given in the following tables:—

Direction of wind		N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
Values of	R ...	0·6	0	−0·7	−1·0	−1·3	−1·2	−0·8	−0·1	0·4	0·6	0·9	1·2	1·6	1·5	1·3	0·9
	R_b ...	12	11	10	9	7	6	7	8	8	6	6	8	10	12	14	13
	R_τ ...	1·1	1·4	1·3	0·6	−0·2	−0·8	−1·0	−1·2	−1·3	−1·1	−0·8	−0·6	−0·3	0·2	0·6	0·9
	$R_{b\tau}$ ...	0	0	1	3	4	5	5	5	5	5	5	5	6	6	3	1

The way in which the values of K and K_τ are to be chosen, depend on the way of observing the force of the wind. The mentioned relation between pressure, velocity of the wind, and the value of K and K_τ permits the choice of the proper value of the latter, pressure or velocity of wind being given.

If the force is estimated in degrees of the Beaufort scale, as is usual among mariners, we may choose K and K_τ according to the following table:—

Degrees of Beaufort scale	K=	K_τ=
0	0·4	1·5
1	2	3
2	6	4·5
3	10	6·5
4	16	8
5	25	10
6	36	12
7	50	15
8	70	18
9	90	21
10	110	25

The mean age of the effect of wind and atmospheric pressure in the calculation being considered as six hours, which is not far from the truth, we may consider that the prediction of the next high water in general ought to be corrected with the observation of wind and barometer at about the preceding low water; a case which will often occur in practice, when vessels wait for the rising water to enter into the harbour.

Suppose a sea captain approaches a harbour entrance, and wishes to determine the correction for the next high water, in order to apply it to the predicted height of the tide-table. He therefore observes direction and force of the wind, and also the state of the barometer, and finds, for instance:—

Direction	N.
Force	7 Beaufort.
Barometer	77·5 centimetres.

The values to be found in the given tables are:—

$$K = 50 \quad R = 0{\cdot}6 \quad R_b = 12.$$

The correction $C = (50 \times 0{\cdot}6) - 3 - 12(77{\cdot}5 - 76{\cdot}0) = 30 - 3 - 18 = 9$ centimetres.

Thus the high water-level will be raised by 9 centimetres above the predicted height of the tide-table.

It will be easy for English mariners to change these formulæ into others, expressed in feet and inches instead of in centimetres.

At the end of these deductions it will, perhaps, not be out

of place to state that the calculations give an approximation, and that no absolute reliance can be placed on the formula.

The effects to which the level of the sea is subject are so many and so varied, and there may be in operation agencies acting over a distant area which cannot be discovered by local observation, or which may have been in operation on previous days, that it will never be possible to give a correction of mathematical exactitude.

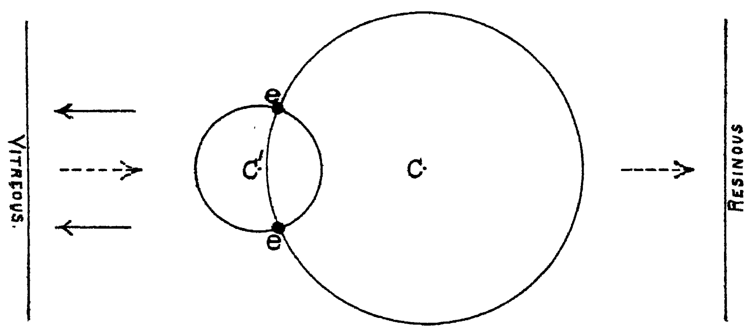
But every indication which approaches truth, and which increases our knowledge, is useful, and in this light the formulæ given should be considered. F. L. ORTT.

The Hague, Holland.

CONTACT ELECTRICITY AND ELECTROLYSIS ACCORDING TO FATHER BOSCOVICH.

YESTERDAY evening, in the Royal Institution, I spoke of an ideal one-fluid electricity subject to attractions of solid substance, to account for contact electricity of metals; and I said that before the end of our meeting I might speak of it further and might have to reverse the conventional language I was using as to positive and negative, and call resinous electricity positive, and vitreous negative. My allotted hour was woefully overpast, and half an hour more gone, before

CONFIGURATION BEFORE ACTION OF ELECTROLYTIC FORCE



ELECTROLYTIC FORCE SHOWN BY ARROWS.

I could return to the subject; and I felt bound to stop. What I wished to say may be said in the columns of NATURE in fewer words than I could have found, to make it intelligible, last night.

Varley's fundamental discovery of the kathode torrent, splendidly confirmed and extended by Crookes, seems to me to necessitate the conclusion that resinous electricity, not vitreous, is *the electric fluid*, if we are to have a one-fluid theory of electricity. Mathematical reasons, to which I can only refer without explanation at present, prove that if resinous electricity is a continuous homogeneous liquid, it must, in order to produce the phenomena of contact-electricity which you have seen this evening, be endowed with a cohesional quality such as that shown by water on a red-hot metal, or mercury on any solid other than a metal amalgamated by it. It is just conceivable, though it does not at present seem to me very probable, that this idea may deserve careful consideration. I leave it, however, for the present, and prefer to consider an atomic theory of electricity foreseen as worthy of thought by Faraday and Clerk Maxwell, very definitely proposed by Helmholtz in his last lecture to the Royal Institution, and largely accepted by present-day theoretical workers and teachers. Indeed, Faraday's law of electro-chemical equivalence seems to necessitate something atomic in electricity, and to justify the very modern name *electron*. The older, and at present even more popular, name *ion* given sixty years ago by Faraday, suggests a convenient modification of it, *electrion*, to denote an atom of resinous electricity. And now, adopting the essentials of Aepinus' theory, and dealing with it according to the doctrine of Father Boscovich, each atom of ponderable matter is an electron of vitreous electricity; which, with a neutralising electrion of resinous electricity close to it, produces a resulting force on every distant electron and electrion which varies inversely as the cube of the distance, and is in the direction determined according to the well-known requisite application of the parallelogram of forces.

In a solid metal the ponderable atoms must exert such other mutual forces, compounded with the electric forces, that the assemblage in equilibrium shall have the crystalline configuration, and the elasticity-moduluses, of the metal. The electrions must be perfectly mobile among the ponderable atoms, subject only to the condition that the electric attraction ceases to increase according to the inverse square of the distance and becomes zero (or, perhaps, strong repulsion) when the distance is diminished below some definite limit. For simplicity we may arbitrarily assume the following conditions:

(1) Each electrion is a point-atom of resinous electricity and repels every other electrion with a force varying inversely as the square of the distance between them.

(2) Each electrion is attracted by each ponderable atom with a force which varies inversely as the square of its distance from the centre of the ponderable atom when the distance exceeds a certain limit r and is zero when the distance is less than r.

(3) The shortest distance between two centres of ponderable atoms need not be limited to be $>2r$: it may be whatever we find convenient for the structure and properties to be realised. It will be $>2r$ in an insulating solid and $<2r$ in a conductor.

Two pieces of metal, M, M′, each constituted as I have now explained, will behave in respect to contact-electricity just as two pieces of metal behave in a perfect vacuum. For example, if $r>r'$, M will behave to M′ as zinc behaves to copper.

To illustrate electrolysis, consider an ideal case of a detached compound zinc-copper atom, composed of two single atoms with their centres at C, C′; and two electrions e, e which must, for equilibrium, be in the positions shown in the diagram, if r, r' be of such magnitudes as the radii of the circles showing the shortest distances to which C and C′ attract electrions. Let now electrified bodies at great distances (such as the vitreously and resinously electrified plates indicated in the diagram) act in the manner indicated by the dotted arrows relatively to the ponderable atoms, and the full arrows relatively to the electrions. The ponderable atom C will be drawn away to the right by the electric force on itself: and the ponderable atom C′ will be dragged away to the left by the two electrions overcoming the rightward force which itself experiences in virtue of the electric field. Lastly, to take a real case, the electrolysis of copper-sulphate, let C′ be the centre of an atom of copper in combination with oxysulphion (SO_4), not shown in the diagram; with, in all, six electrions. The copper atom C′ will be drawn away to the right, with no electrion attached to it: and the oxysulphion will be pushed and dragged to the left by the excess

of leftward electric forces on the six electrions above rightward electric forces on the five ponderable atoms.

KELVIN.

London, May 22.

NEW OBSERVATIONS ON THE LARVA OF THE COMMON EEL.[1]

IN our last note we announced that we had succeeded in following the transformation of *Leptocephalus brevirostris* into *Anguilla vulgaris*, and that the proof had been repeated by Prof. Ficalbi.

Our discovery was thus also confirmed by experiment. We were therefore ready to publish our work *in extenso*, and only regretted that we were unable to supply figures of the intermediate stages between the transparent (blind) Anguillina and the *Leptocephalus brevirostris* with its larval teeth still intact. The only example of this Leptocephalus obtained in a fit condition to survive and undergo its transformations in aquaria—that is to say, one uninjured and sufficiently advanced in its development (already deprived of a considerable proportion of its larval teeth), had already been made the subject of the above-named experiment.

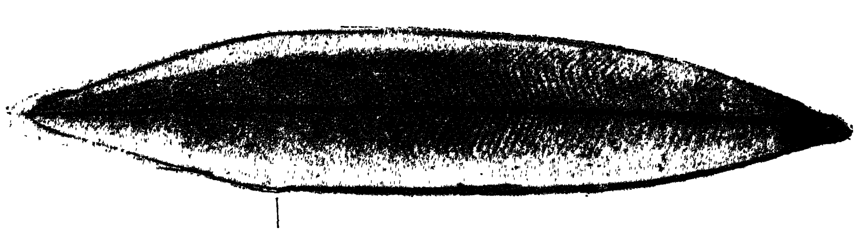


FIG. 1.—*Leptocephalus brevirostris*, with its larval teeth still intact (enlarged).

An unexpected chance has, however, fortunately procured us a *Leptocephalus brevirostris* which had acquired such characteristics as to convince anyone of the reality of the metamorphoses discovered by us. We think it desirable to give a preliminary notice of this precious specimen, by publishing an illustration of it by the side of that of another *Leptocephalus brevirostris* still having its larval teeth intact.

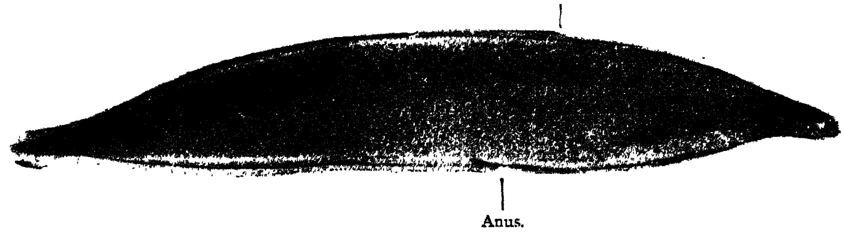


FIG. 2.—*L. brevirostris* captured by Dr. Silvestri (enlarged on the same scale as the preceding).

The present specimen was captured, last January, by Dr. Silvestri in the Straits of Messina.

Its total length is 71 mm. The anus is at about 29 mm. from the apex of the snout, the anterior extremity of the dorsal fin being about 25 mm. from the apex of the snout.

The head and the point of the tail have already noticeably acquired the known special characteristics of the eel.

The larval teeth have totally disappeared, while the distinctive ones seem still entirely absent.

It lacks all traces of pigment.

We will not proceed to further particulars, reserving them for our larger work.

[1] "Description of a *Leptocephalus brevirostris* in process of transformation into *Anguilla vulgaris*." Preliminary Note by G. B. Grassi and Dr. S. Calandruccio. Translated from the *Atti della Reale Accademia dei Lincei*, vol. vi. pp. 239–40, 1897.

TORONTO MEETING OF THE BRITISH ASSOCIATION.

II.—LOCAL ARRANGEMENTS.

THE material for the "Handbook of Canada," which is being prepared for the meeting, under the direction of the Publication Committee, is now complete, and there is every ground for believing that a large number of copies of the book will be ready about July 15, for distribution in England amongst the members of the Association who propose attending the Canadian meeting. The aim of the handbook is to give information on the Geography, Geology, Natural History, and Economic Resources of Canada. It will embrace chapters also on Public Administration and on the History of the Dominion. The Chairman of this Committee, Prof. Ramsay Wright, has succeeded in enlisting in the preparation of this work the aid of the most expert Canadian authorities, and there is no doubt that the publication, when it appears, will be regarded as a valuable guide to the Dominion.

In all probability the meeting will have a special distinction in the very large attendance of foreign men of science, an attendance larger than that of any previous meeting. The presence of the Presidents of a number of the leading American Universities, with a very large representation of the scientific members of their Faculties, will make the occasion one of very great interest to both nations. Out of this has again risen the suggestion to form an International Association for the Advancement of Science, and it has been pointed out that the nucleus of such an organisation can be formed at Toronto from the representative men from Europe and America in attendance here. The first meeting, according to this proposition, would be held in Paris in 1900.

His Excellency, the Governor-General of Canada, and Lady Aberdeen have accepted the invitation to be present at the meeting, and have arranged to hold a special Reception for the members of the Association, probably in the new Legislative Buildings, during the evening of August 19. His Excellency takes a deep interest in the coming meeting, and has expressed a wish to do what is possible to make it a success. The Lieutenant-Governor of Ontario, the Hon. G. A. Kirkpatrick, and Mrs. Kirkpatrick have also graciously offered to hold a reception for the members.

The Local Committee recognise how interesting the country about and near Toronto is from a scientific point of view and they have made arrangements whereby the

more important points can be seen under competent guidance. Prof. Coleman has undertaken to conduct a party interested in geology to examine the Glacial Beds of the Don Valley immediately east of Toronto. Here are found drift deposits more than 200 feet thick, resting directly on Silurian strata, and containing an abundance of fossils of extinct animal and vegetable forms which point to a climate in Glacial times considerably warmer than that which now obtains in the temperate zone. The change in the lake level brought about since the Glacial Era, is shown by the old shore-line of the ancient lake ("Iroquois Water") demonstrated in these deposits, which is 170 feet above the surface of the present Lake Ontario. At Scarboro' Heights, a few miles further east, the beds reach a thickness of 350 feet. The excursion to be conducted along the course of the Niagara River to the Falls will be under the guidance of two geologists who have made a special study of the region. The vertical walls of rock, 200 feet high, provide an admirable section of the Silurian strata of the region; and the marvellous history of the Falls and the great lakes and rivers of the St. Lawrence chain of waters will be illustrated on the spot.

The excursion to the Niagara region will be made on Saturday, August 21, and that to the Don Valley and Scarboro' Heights on August 23.

The Muskoka Lakes Association, formed of a large number of public-spirited Canadians, are making special arrangements for the excursion to the Muskoka Lake region. Some of the loveliest bits of scenery are to be found in this locality, and a stay of a couple of days (August 21–23) will constitute a very pleasant feature in the programme of the meeting. Many of the members who will take this excursion will be received as guests amongst the members of the Muskoka Lakes Association who have summer residences and camping-grounds on the islands. The Muskoka Lake Navigation Company have arranged for special trips of their steamers on the occasion. The railway fare from Toronto to Muskoka and return will probably be a nominal one.

It is generally recognised that this will be the last occasion for many years on which Canada will be honoured by the visit of so many scientific men, many of whom are veterans in the scientific progress of the nineteenth century, and it is felt that the opportunity should not be allowed to pass without attempting in some way to show the appreciation which Canadians have for the services rendered by them to science. It has in consequence been arranged to give a public banquet in honour of Lord Kelvin, Lord Lister, and Sir John Evans, the President-elect of the Association. The University of Toronto will, to judge from present indications, hold a special convocation during the meeting, at which, doubtless, a number of honorary degrees will be conferred.

The Cataract Construction Company of New York have very extensive electrical plant at Niagara Falls, which generates a large part of the current which supplies Buffalo and the neighbourhood. The Company has generously invited the members of the Association to inspect the plant, and it will arrange specially for the reception of the members who will accept the invitation.

The Director of the Harvard Astronomical Observatory has issued a special invitation to the members of the Association who are interested in astronomy, and who may be in Boston, to visit the Observatory.

The loss sustained by the American Association in the death of its President, Prof. E. D. Cope, is a severe one, and occurs at a critical time. Prof. Cope, it is understood, is to be succeeded by Prof. Theodore Gill, senior Vice-President of the Association, and there will consequently be no interruption in the arrangements for the session. The Council of the Association, at its recent meeting, resolved to extend to all the members of the British Association who will attend the Detroit meeting the privilege of honorary membership. It has also been proposed that, in the interval between the Toronto and the Detroit meetings, the members of the American Association take an excursion trip, the terminal point of which would be Toronto, and its final day August 18.

A. B. MACALLUM.

NOTES.

PROF. E. A. SCHÄFER, F.R.S., is unavoidably prevented from attending the forthcoming meeting of the British Association at Toronto, and in his absence the duties of General Secretary will be undertaken by Prof. W. C. Roberts-Austen, C.B., F.R.S., who will also deliver one of the evening discourses, on "Canada's Metals." The other evening discourse will be given by Prof. John Milne, F.R.S., on "Earthquakes and Volcanoes." The Council of the Association have resolved to nominate Mr. W. Crookes, F.R.S., as President for the meeting to be held at Bristol next year. We have already printed (March 25, p. 494) the list of the presidents of the various sections of the Toronto meeting.

AT the anniversary meeting of the Linnean Society, held on Monday, the gold medal of the Society was awarded to Dr. Jacob Georg Agardh, Emeritus Professor of Botany at the University of Lund, the distinguished algologist, and author of the "Species, Genera, et Ordines Algarum," which contains the first embodiment of the natural system applied to marine algæ as a whole. Greville, Harvey, and Kützing, no doubt, paved the way and made this task possible, but it nevertheless remains a monument of research and true systematic judgment. In 1872 he commenced a series of memoirs, "Till Algernes Systematik," which he completed in 1890; another great work, "Florideernes Morphologi," having appeared meanwhile in 1879. Ten years later he published his "Species Sargassorum Australiæ"; and in 1892, in his eightieth year, commenced a remarkable series of memoirs, the "Analecta Algologica," the completion of which he has happily achieved. In his unavoidable absence from England, the gold medal just awarded to him was received on his behalf by His Excellency the Minister for Sweden and Norway.

PROF. FELIX KLEIN, professor of mathematics in Göttingen University, has been elected a Correspondant in the Section of Géométrie of the Paris Academy of Sciences, in succession to the late Prof. Sylvester.

THE death of Sir Augustus Wollaston Franks, K.C.B., F.R.S., President of the Society of Antiquaries, will be deeply regretted by all archæologists. From an obituary notice in the *Times* we learn that Sir A. W. Franks was born in 1826, and was thus in his seventy-second year. He early developed the taste for mediæval archæology, upon which he afterwards became the leading authority. In 1849 his "Ornamental Glazing Quarries" was published, and among his other archæological works may be mentioned "Medallic Illustrations of British History," and an edition of Kemble's "Horæ Ferales," a volume which his additions converted into a standard work. He entered the British Museum as an assistant in 1851, and afterwards became Keeper of the Department of British and Mediæval Antiquities, and of Ethnography. Not only his own, but other sections of the Museum, bear witness to his catholic taste and great liberality. Upon his retirement from the Museum, he was placed on the Standing Committee, and took an active part in the work up to the time of his death. For some time he was Director of the Society of Antiquaries, and in 1891 he was elected President of the Society for a period of seven years. The Society as well as the Museum was

familiar with his liberality, and quite recently he presented to the Society some hundred volumes from his antiquarian library. His principal discovery in archæology was to separate the work of the age which produced what he called "Late Celtic" antiquities from that of the age which preceded and followed it. His persistency as a collector, moreover, managed to secure for the nation the best collection that exists of the remains of this period—a period which lies on the borderland between the prehistoric and historic periods in Britain, and about which antiquarian relics are our only means of knowledge. He was elected a Fellow of the Royal Society in 1874.

THE fund established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to 26,000 dols. (5200*l.*). We are informed that, as accumulated income will be available in November next, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but the trustees give the preference to those investigations, which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from this fund, in order to receive consideration, must be accompanied by full information, especially in regard to the amount required, nature of the investigation proposed, conditions under which the research is to be prosecuted, manner in which the appropriation asked for is to be expended. All applications should reach, before November 1, 1897, the Secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A. Decided preference will be given to applications for small amounts, and grants exceeding 300 dols. will be made only under very exceptional circumstances. It appears from the list we have received, that of the seventy-one grants hitherto made, three have come to Great Britain, viz.: 150 dols. to Dr. Samuel Rideal, for investigations on the absorption of heat by odorous gases; 125 dols. to Mr. Edw. E. Prince, of St. Andrews, for researches on the development and morphology of the limbs of teleosts; and 250 dols. to Mr. Herbert Tomlinson, F.R.S., for researches on the effects of stress and strain on the physical properties of matter. Twenty-four of the remaining grants were given to men of science in America, twenty went to Germany, five to Switzerland, four to France, three to Belgium, three to Canada, and two to Italy.

DR. CHARLES W. DABNEY has been appointed "special agent in charge of scientific and statistical investigations" of the U.S. Department of Agriculture.

THE steamer *Bear* left Seattle on May 6 for the Arctic regions, having on board surveying parties of the United States Coast and Geodetic Survey, who have gone to survey the Pribyloff Islands.

THE *Times* correspondent at Copenhagen states that the "Carlsberg Fund" for scientific purposes has offered 150,000 kroner (about 8300*l.*) to the Danish scientific expedition to the east coast of Greenland, for the purpose of making a chart of the coast northwards to Angmagsalik.

AN "at home" was held by the President and Council of the Geological Society at the Society's Rooms in Burlington House, on Wednesday, May 19, when Mr. E. J. Garwood, who was a member of Sir Martin Conway's expedition to Spitzbergen, gave some account of the geology and glacial phenomena of that region.

THE annual report of the Brooklyn Institute shows steady growth in membership. Sir Archibald Geikie delivered before the Institute, on May 10, an illustrated lecture on the Hebrides. In the course of the lecture he remarked that he had never been able to understand the remarkable volcanic phenomena of these islands till his visit to the volcanic region of the western part of the United States eighteen years ago.

WE regret to have to include in this week's obituary the names of Mr. Martin L. Linell, assistant in the Department of Insects of the U.S. National Museum; Dr. C. A. L. Robertson, distinguished for his work in medico-psychology, and joint editor of the *Journal of Mental Science;* and Mr. John Ramsbottom, president of the Institution of Mechanical Engineers in 1870-71.

A SEVERE shock of earthquake, which lasted six or seven seconds, was experienced at Guadeloupe, West Indies, at 10.30 a.m. on April 30. It was most strongly felt at Pointe à Pitre, where the stone gable-end walls of over a hundred houses fell and crushed adjoining buildings. Several minor shocks were felt after the first disturbance. No premonitory sounds were heard.

THE report of the medical superintendents to the Metropolitan Asylums Board on the use of antitoxin in the treatment of diphtheria during the year 1896, has just been presented to the Board. The statistical results with regard to mortality are compared with those for 1894, the year immediately preceding the introduction of antitoxin, and the one in which the lowest mortality had been recorded up to that time; they show a marked improvement in all classes of cases, and especially in the severer ones. "We have had, in fact," the report states, "somewhat better results to record for 1896 than we had for 1895. . . . We have only to add that we still hold to the opinion that in the antitoxic serum we possess a remedy of distinctly—we would now say much—greater value in the treatment of diphtheria than any other with which we are acquainted."

THE conference of the members of the Institution of Civil Engineers was opened on Tuesday, under the Presidency of Mr. J. Wolfe Barry, C.B., F.R.S., President of the Institution. The President, in an address to the combined Sections, congratulated the members who had taken part in the designing and construction of the Blackwall Tunnel upon the successful completion of that work. He then gave an outline of the birth, parentage, and career of the Institution, which dates from 1818. At the conclusion of the address the work of the various Sections began. A conversazione was held on Tuesday evening, and was attended by some 1500 guests.

A GENERAL meeting of the members of the Federated Institution of Mining Engineers will be held in London, on Thursday (June 3) and Friday (June 4). The following are among the papers to be read:—"Presidential Address," by Mr. Lindsay Wood; "Machine Coal-mining in Iowa, U.S.A.," by Mr. H. Foster Bain; "Occurrence of Cinnabar in British Columbia, Canada," by Mr. W. Hamilton Merritt; "Notes on a Boring at Netherseal, Ashby-de-la-Zouch, Leicestershire," by Mr. G. J. Binns, with stratigraphical remarks by Mr. C. Fox-Strangways, and petrographical remarks by Mr. W. W. Watts; "The South Wales Anthracite Coal-field," by Mr. Morgan W. Davies; "The Lake Superior Iron Ore Region, with special reference to the Masabi Range," by Mr. Horace V. Winchell; "Gold in Nature," by Captain C. C. Longridge.

AN air-ship made a remarkable ascension from Nashville a few days ago, under the management of Mr. A. W. Barnard. The air-ship is a cylindrically-shaped silken bag, with rounding ends, and is 42 feet long and 16 feet wide, enclosed in a netting

which is attached to a beam. Ten feet below from this beam a saddle is suspended, with pedals like a bicycle, by which the four-bladed propeller, 10 feet in the rear of the aeronaut, is turned. Hydrogen gas was used to inflate the ship. After the ship had risen to the height of about 500 feet, the aeronaut turned completely around, to show that the propeller was effective. He continued rising till he was out of sight, and propelled the machine in a direction diagonally to the wind at a rate of ten or twelve miles an hour. After travelling fifteen miles, he returned to within four miles of the city; but he had to rise and fall so many times that his supply of gas became exhausted, and also one of the blades of his propeller broke, and he descended.

IT is stated in the *Times* that, in accordance with the recommendations of the Departmental Committee on Dogs, upon which the Board of Agriculture have already taken action in London, Lancashire, Yorkshire and the Midlands, a muzzling order will shortly be issued by the Irish Privy Council, and that, as the cases of rabies in Ireland are so widely scattered, the order will extend to the whole of that country. The Irish Privy Council intend also to issue an order relating to the importation of dogs, following closely upon the lines of the order already sanctioned for Great Britain, and referred to last week (p. 60). This combined action gives us reason for hope that rabies will some day be exterminated from our islands.

THE President of the Board of Trade has appointed a Committee, consisting of Sir Charles Hall, Q.C., K.C.M.G., M.P. (Chairman), Mr. James Alward, Mr. T. Gibson Bowles, M.P., Captain A. J. G. Chalmers, Rear-Admiral W. J. L. Wharton, C.B., F.R.S., Mr. Charles H. Wilson, M.P., to consider and report whether any, and, if so, what, alterations or additions are required in the regulations for preventing collisions at sea, as regards (1) the lights to be carried and exhibited, and the signals to be carried and used, by sailing ships, steam ships, and boats when engaged in fishing; (2) the expediency of requiring all ships to keep out of the way of steam ships when such ships are engaged in fishing; (3) the lights to be carried and exhibited by steam ships carrying pilots when engaged on their stations on pilotage duty.

A REMARKABLE glacial eruption occurred in the early months of the present year in the south of Iceland. A postman was crossing the sands of Skeidara, when suddenly he heard the glacier about two miles in front of him emit a long, groaning sound, and saw large masses of ice being hurled into the air from the glacier, immediately followed by a flood that descended upon the level sands, surging to and fro and carrying everything before it. He promptly turned his horse and rode away to the station of Nupsstad, on the western side of the glacier. Six days later he returned to the sands, and saw them as a belt of ice-waves extending from the glacier to the sea, a distance of at least twenty-five miles. The average breadth of this belt was about four miles. The height of the ice-floes or waves varied from 70 feet to 90 feet. It was impossible to cross this wall of ice except close by the foot of the glacier where the floes were far apart. On the other side of the ice-field were six newly-formed torrents rushing from the glacier. No damage to life or property was caused by this eruption, which is believed to have some connection with the severe earthquakes of last summer.

THE Report on Admiralty Surveys for the year 1896, by the Hydrographer, Rear-Admiral Wharton, C.B., F.R.S., has just been published as a Blue-book. Notwithstanding the progress of hydrography, and the constant employment of our own and foreign surveying vessels in many parts of the world, the requirements of modern steam navigation increase more rapidly than the advance of surveys. Every year newly-discovered rocks are reported, the number of which shows no signs of diminishing. During the year 1896 no less than 209 rocks and shoals which were dangerous to navigation were reported, and required to be notified to the public by notices to mariners. Among the many observations recorded in the report, we notice that the Goodwin Sands has continued its general movement towards the coast, and the area of drying sand has very largely increased since the last ten years, when only small parts of the bank were above low water. An account is given of the part taken by H.M.S. *Penguin* in the coral-boring expedition sent by the Royal Society to Funafuti Island, Ellice Group. Reference is made to the determination of the contour of the outer slopes of the atoll; and it is also pointed out that the soundings obtained by H.M. surveying ships during the past few years in the south-western part of the Pacific, on the course of their voyages from and to Australia, have very largely added to our knowledge of the conformation of the bottom, and valuable information has been collected for submarine telegraph cables, if required. H.M.S. *Waterwitch* was engaged at Tasmania and the Fiji Islands in 1896. A line of soundings run towards Norfolk Island, and from thence to Smoky Cape on the Australian coast, passing between the Elizabeth and Middleton reefs, disclosed the interesting fact that these reefs are not on the comparatively shallow ridge that connects New Zealand with Queensland, but rise from deep water on its flanks.

WE have received the Report of the Director of the Liverpool Observatory for the year 1896. In addition to the transit and other astronomical observations required by the Mersey Docks and Harbour Board, special attention has been given at this observatory to anemometrical observations, and various interesting papers have from time to time been published upon this subject, *e.g.* one on the velocity of the wind at Liverpool, by the late W. W. Rundell, based upon the data between 1852 and 1866. During the past year, Mr. W. E. Plummer has made a number of comparisons between the results obtained from a Dines' tube anemometer and the Robinson cup and Osler plate anemometer. The values of the first two have been recorded under eight principal points of the compass, and Mr. Plummer states that the result of the comparison is to some extent a surprise, as it was anticipated that the record of the Robinson instrument would be much too great, owing to the wind velocities being computed on the assumption, now generally regarded as erroneous, that the wind travelled at three times the velocity of the cups. The experiments, however, go to show that the appropriate factor to reduce the Robinson velocities to the Dines standard is not so low as was expected, and that the velocities published in past years have not been in error by so great an extent as 10 per cent. It is important to remember, however, that in such comparisons much depends not only upon a proper exposure, but upon the size of the cups and the length of the arms of the instrument employed.

DR. C. DIENER, of Vienna, contributes to the *Mittheilungen der K. K. geographischen Gesellschaft* in Vienna an exhaustive discussion of the bearing of geological research on the destruction of Sodom and Gomorrah. The Scriptural account of the catastrophe is examined in detail, and the descriptions of travellers are employed to work out a complete picture. From a comparison with similar more recent disturbances in various parts of the globe, Dr. Diener concludes that the cities of Pentapolis were overwhelmed by a violent earthquake affecting the whole basin of the Dead Sea, and following upon a series of minor undulatory movements. Masses of subterranean water were forced up to the surface, giving rise to extensive landslips, and

consequent inundation of large districts by the waters of the Dead Sea. At the same time the shock reopened the crater of a volcano on the eastern margin of the sea, and a violent eruption followed. This account, in Dr. Diener's opinion, best satisfies the geological conditions observed, and it may be admitted that it confirms the descriptive accuracy of the Biblical narrative.

THE new number of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains two important memoirs—one by Dr. G. Schweinfurth on the stone quarries of the Mons Claudianus in the Eastern Egyptian Desert, and one by Dr. Hans Steffen on the relations of Patagonia to the frontiers of Argentina and Chili. Dr. Steffen's paper is illustrated by an excellent map of an almost unknown region.

DR. ARTHUR KEITH has reprinted his four papers on the Anthropoid Apes, published in *Natural Science* during last year, and has formed thereby a very useful index to the literature of these important animals. The books and papers on this subject are, as Dr. Keith observes, much more numerous than most people imagine, and are, moreover, scattered about in the publications of all parts of the world. New contributions to this engrossing subject cannot satisfactorily be made without a full knowledge of what has been previously written. This is, therefore, a most useful piece of work, for which naturalists should be duly grateful to the author.

THE work undertaken by Prof. Balfour Stewart, some years ago, in conjunction with Mr. W. W. Haldane Gee, and entitled, "Lessons in Elementary Practical Physics," was unfortunately interrupted by the death of Prof. Stewart, who only saw the completion of the second volume—that on Electricity and Magnetism. It has now been decided to complete the work by entrusting it to the hands of separate coadjutors; accordingly part 1 of volume iii. will appear immediately, containing a treatise on "Practical Acoustics," by Mr. C. L. Barnes. Part 2 of volume iii. will be a treatise on "Heat," by Mr. Haldane Gee; while the third part, completing the volume, will comprise "Optics."

AMONG noteworthy papers and other publications which have come under our notice during the past few days are the following:—*The Psychological Index*, No. 3, being a bibliography of the literature of psychology and cognate subjects for 1896, compiled by Mr. H. C. Warren and Mr. Livingston Farrand. This valuable index is a special issue of the *Psychological Review*.—Six fine portraits of the late Prof. E. D. Cope are given in the May number of the *American Naturalist*, together with several appreciative notices of his life and work.—A detailed obituary of the late Prof. Du Bois Reymond is contributed to the *Revue de l'Université de Bruxelles* by Prof. Paul Heger.—A catalogue of works on pure and applied mathematics, from the libraries of the late Prof. Cayley and Dr. Todhunter. These books and papers are offered for sale by Messrs. Macmillan and Bowes, and the list of them will interest many mathematicians and astronomers.—Dr. James Cappie contributes to the *Monist* (April) some suggestive considerations on the bearing of elementary physical principles on intercranial activities.

IN view of the growing use of acetylene for heating and illuminating purposes, it has become of importance to find out under what conditions the storage of the gas may become dangerous. Some time ago MM. Berthelot and Vieille found that an explosive decomposition could be set up in acetylene either by a fulminate cap or by a red-hot wire, provided that the pressure was above two atmospheres, this explosive decomposition taking place with extreme ease in the case of the liquefied gas. In the latter case, the effects of the decomposition were similar in character to those produced by high explosives. These results were only too rapidly confirmed by the fatal explosion in Paris of a cylinder of liquid acetylene. It has recently been found out that acetone is a good solvent for acetylene, and in the *Comptes rendus* (May 10) MM. Berthelot and Vieille give an account of their very complete experiments on this solution. After examining the relations between pressure and temperature for solutions of various strengths, they next studied the effects produced by exploding a small charge of mercury fulminate, and by a red-hot wire. It was found that solutions of acetylene in acetone, although still capable of explosion, were much safer than the gas alone, the pressure at which explosion began to be possible being raised from two to ten kilograms per square centimetre. For a given sized vessel the quantity of acetylene that can be safely stored is fifty times greater with acetone than without it.

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-East Brazil, presented by Mr. W. A. Bromwich; a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. T. H. Rudkin; two Bonnet Monkeys (*Macacus sinicus*) from India, presented by Mrs. Hardisty; a Cape Hunting Dog (*Lycaon pictus*) bred in Ireland, presented by the Royal Zoological Society of Ireland; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Dr. J. Martin Kennedy; a Peregrine Falcon (*Falco peregrinus*), captured in the Red Sea, presented by Mr. J. Kilpatrick; an Alexandrine Parrakeet (*Palæornis alexandra*) from India, presented by Mrs. E. Hight; three Cocteau's Skinks (*Macroscincus cocteaui*) from the Island of Raza, Cape de Verde, presented by Mr. Boyd Alexander; an Antillean Boa (*Boa diviniloque*) from St. Lucia, presented by Captain Digby H. Barker; a West African Python (*Python sebæ*) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; a Smooth-headed Capuchin (*Cebus monachus*, albino) from South-east Brazil; two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, two Blue Penguins (*Eudyptula minor*) from New Zealand, deposited; two Wallabys (*Macropus*, sp. inc.), an Australian Pelican (*Pelecanus conspicillatus*) from Australia, purchased; a White-tailed Gnu (*Connochetes gnu*) from South Africa, received in exchange; a Japanese Deer (*Cervus sika*), a Patagonian Cavy (*Dolichotis patachonica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE ORIGIN OF SOLAR AND STELLAR LIGHT.—We have received a small pamphlet of eight pages (including the preface and a supplement) entitled "The Explanation of the Origin of Solar and Stellar Light, and the minor phenomena connected therewith," written by Mr. M. R. Dissett, and published at the moderate (?) price of one shilling. The author of these pages expounds a theory of the universe in which the element of "temperature" plays no *rôle* whatever; in fact, he says "it requires only magnitude and distance sufficient for any non-luminous body to become a brilliant star." Indeed, he goes on to say, "the fact that all the heavenly bodies, without exception, the rarest gases as well as the most solid bodies, give light in proportion to their magnitude, density and distance, might long ago have suggested that their brilliancy must be due to some such principle and not to their being incandescent matter, a theory as puerile as it is unscientific." The "principle" alluded to in the extract, is none other than that by which the light "reflected by a comparatively dull body, such as a planet, becomes more intense as its apparent disc diminishes in increasing distance, till finally it becomes a brilliant star." Arguing from this, the author explains how our sun does not shine by his own light, but is non-luminous and reflects star light. In fact, he infers that every body in the heavens appears bright on this principle. One might be inclined to ask whence the original light, since every body seems to be capable only of

reflection, comes. This difficulty is also explained on this "principle," for it "accounts for how light itself is generated, for the forces that generate light . . . are everywhere at work, though the result may not be immediately apparent to our senses." As this "principle" seems to be capable of enlightening astronomical science on so many points, we think we have mentioned enough of them for the reader to imagine the rest.

THE NEBULA OF ORION.—Two publications of the observations of the nebula of Orion have recently come to hand, one relating to eye observations, and the other restricted to photographic work. The former of these forms part of the publications of the "Leander McCormick Observatory of the University of Virginia" (vol. i. part 7), and consists of the eye observations made by the Director, Mr. Ormond Stone. A minute comparison of the results obtained by this survey with those given in the second publication should no doubt prove of great interest. This latter work we owe to Dr. Scheiner; it forms the second part of the eleventh volume of the "Publicationen des Astrophysikalischen Observatoriums zu Potsdam." In this Dr. Scheiner has investigated the details of this nebula as registered by several photographs, and he had also, with the intention of tracing some relationship between the nebula and the stars in and around it, completed a rigorous measurement of the position of the stars on the photographic plates. The main result of the investigation shows that undoubtedly there is a relationship between the nebula and the neighbouring stars. This result is satisfactory in that it is just what we should expect on the meteoritic hypothesis, and further corroborates Mr. Isaac Roberts's recent work, which also indicated a close connection between stars and nebulæ.

THE PARALLAX OF 61^1 CYGNI.—Mr. Herman S. Davis contributes to the *Astronomical Journal*, No. 402, the results of his investigation of the parallax of 61^1 Cygni. In this work he has employed the nineteen negatives of this star taken, between the years 1871–74, by Mr. Rutherfurd. The methods of reduction by differences of distance of two stars, having approximately equal distances, and differing about 180° in position-angle, are here the same as were employed for the parallax of μ, θ and η Cassiopeiæ in previous investigations. In addition to measures of distance, those of angle have here been employed. Taking the means of the values given in the *Astronomical Journal*, that for measurement of distance is $+0''.3999 \pm 0''.0230$, and for measurement of position-angle $+0''.3326 \pm 0''.0189$. The resulting value for the mean relative parallax of this star is therefore $+0''.360 \pm 0''.0146$. Mr. Davis adds that a complete discussion of the measure of 61^1 Cygni will soon be published as Contribution No. 13 from the Observatory of Columbia College.

THE ROYAL SOCIETY CONVERSAZIONE.

THE first of the two conversazioni held annually at the Royal Society took place on Wednesday, May 19. The following is a list of the exhibits:—

Illustrations of the Dansac-Chassagne process of producing photographs in colour: Sir H. Trueman Wood.

Apparatus for ascertaining duration of explosion, pressure developed, and rate of cooling of products of combustion: Sir A. Noble, K.C.B., F.R.S. The recording instrument consists of a rotating drum on which two pencils mark (1) seconds, (2) the pressure in tons per square inch indicated by a specially designed manometer; the pressure pencil traces out a curve, from which can be deduced the approximate time of explosion, the pressure reached, and the rate at which the gases cool; a second instrument is attached, on which the pressures and seconds are indicated by small electro-magnets.

Stress effects produced by convective electric discharges: Mr. J. W. Swan, F.R.S.

Apparatus for the comparison of thermometers: Mr. W. Watson.

A powerful electrical influence machine: Mr. J. Wimshurst. The machine has 24 discs, each 3 feet in diameter; they are so arranged as to furnish three poles, one of which may be negatively charged, the other two poles positively charged, or at pleasure the reverse order may be followed; by this arrangement two separate streams of discharge may be in use at the same moment.

(1) Model of a Hertz wave transmission; (2) two kinematic models: Prof. Silvanus P. Thompson, F.R.S.

Graphic representation of the Rothamsted observations on the continuous growth of wheat: Dr. H. E. Armstrong, F.R.S.

Certain bones of the ancient Naquada race, exhibiting characters of morphological or pathological interest: Mr. E. Warren.

Restored skeleton of *Æpyornis Hildebrandi* (Burckhardt) from Madagascar. The skeleton exhibited is the *first* and almost complete skeleton of *Æpyornis Hildebrandi* hitherto obtained from Madagascar. *Nesopithecus Roberti* (Forsyth-Major), a fossil monkey of an entirely new genus, and other objects: Dr. C. I. Forsyth-Major. (The collection was made by means of grants from the fund administered by the Royal Society.)

Glacial phenomena of Cambrian or Pre-Cambrian age, from the Varanger Fjord, Norwegian Lapland: Mr. Aubrey Strahan.

Photographs of the moon taken with the new Thompson 26 in. photographic telescope, at the Royal Observatory, Greenwich: the Astronomer Royal.

Photographic Atlas of the Moon, published by the Observatory of Paris; executed by MM. Lœwy and Puiseux: the Library of the Royal Society.

(1) Photographs illustrating enhanced lines in the spectra of the chemical elements, and the importance of such lines in the spectra of the hotter stars. (2) Solar photographs, taken at Dehra Dun, India, showing a kite and a locust projected on the sun's disc. Forwarded by Mr. J. Eccles. (3) Photographs illustrating the spectroscopic results obtained by the Eclipse Expedition to Novaya Zemlya, August 1896. (4) Photographs illustrating preparations and arrangements for the observation of the total eclipse of the sun August 1896, at Kiö Island, Varanger Fjord, Norway: Mr. J. Norman Lockyer, C.B., F.R.S.

Experiments with kathode and X-rays: Mr. A. A. C. Swinton.

A selection of dried plants from Tibet, collected by Captain Deasy and Mr. Arnold Pike, Captain Wellby and Lieutenant Malcolm: the Director, Royal Gardens, Kew.

Photographs illustrating the micro-structure of alloys: Mr. J. E. Stead.

Some photographs of optical projections in space: Mr. Eric Stuart Bruce.

Apparatus showing the phase change of light reflected at a glass-silver surface: Mr. E. Edser and Mr. H. Stansfield. The apparatus exhibited is a modification of Michelson's differential refractometer, the interfering rays being reflected at the back surfaces of the end mirrors. On these surfaces are deposited silver films, one being wedge-shaped, with a horizontal streak rubbed off, and the other uniform. Where vertical bands cross from the glass-air to the glass-silver surface a lateral displacement is produced, which varies from zero at the thin end of the wedge to ⅜ of a band at the thick end. The direction of the displacement indicates a retardation.

Apparatus for micro-photography: Prof. Roberts-Austen, C.B., F.R.S. A microscope and camera is arranged for obtaining photographs of metals and alloys under high magnification. The illustrations show the mode of existence of carbon in steel, and include the diamond form of carbon. The magnifications vary from 500 to 1000 diameters.

Living specimens of *Proteus anguinus*, Laurenti: Mr. E. J. Bles.

A collection of British Medusæ: Mr. E. T. Browne.

(1) Experiments with highly-dilatable and nearly non-dilatable nickel steel; (2) diagrams of expansion; (3) compensated pendulum made of nickel steel: M. C. E. Guillaume, Bureau International des Poids et Mesures.

(1) Superficial colour changes of a silver-zinc alloy; (2) X-ray photographs of sodium-gold alloys: Mr. C. T. Heycock, F.R.S., and Mr. F. H. Neville.

(1) Improved hatchet planimeter; (2) the cyclesograph, an instrument for describing arcs of circles of large radius: Mr. E. K. Scott.

The diffraction kaleidoscope: Mr. C. P. Butler.

A mid-water tow-net: Dr. G. H. Fowler.

Rotating discs, showing subjective colour phenomena: Mr. Shelford Bidwell, F.R.S.

Demonstration of Zeeman's discovery of the broadening of

spectrum lines by the action of a magnetic field on the source of light: Prof. Oliver Lodge, F.R.S.

Commensalism amongst marine animals: the Marine Biological Association.

Experiments on the transmutation of sound vibrations: Mr. J. Gcold.

Examples of animal-forms peculiar to Lake Tanganyika: Mr. J. E. S. Moore.

The Tsetse fly and the parasite of Tsetse fly-disease, or Ngana: Dr. A. A. Kanthack, Mr. W. F. H. Blandford, and Mr. H. E. Durham.

(1) Egg of *Æpyornis maximus* (Grandidier), Madagascar; (2) egg of African ostrich for comparison of size; (3) photograph of a fossil frog (*Discoglossus Troscheli*, Meyer sp.) from the lignite (Miocene) of Rott, near Bonn, and sciagraph of a recent frog of the same genus (*Discoglossus pictus*, Otth), for comparison. By Messrs. James Green and James H. Gardiner: Dr. Woodward, F.R.S., on behalf of Mr. R. Damon.

Ceraterpeton Galvani, Huxley, coal measures, Kilkenny, Ireland: Dr. Woodward, F.R.S., for Mr. J. G. Robertson, of Dublin.

(1) Living specimens of the British Mymaridæ (egg parasites), terrestrial and aquatic; (2) mounted specimens of newly-discovered genera. Mounted specimens of newly-discovered male Prestwichia: Mr. F. Enock.

(1) Specimens of Lepidoptera altered by temperature experiments, and reared by the exhibitor; (2) some of the results of crossings carried out by the exhibitor: Dr. M. Standfuss, of Zürich.

Examples of alteration of insects by temperature applied in the pupal stage: Mr. F. Merrifield.

Some examples of geographical distribution among the micro-Lepidoptera, with specimens from different regions, and coloured maps: Lord Walsingham, F.R.S.

Blood corpuscles of some invertebrate animals. Digestive gland of *Ostrea*: Dr. C. A. MacMunn.

A rotating mirror, specially made to the order of exhibitor by the Cambridge Instrument Co.: Sir David Salomons, Bart.

A rowing indicator, giving continuous record: Mr. F. C. Atkinson.

A new pocket mercurial standard barometer: Prof. J. Norman Collie, F.R.S., and Captain H. H. P. Deasy.

An apparatus for investigating the influence of proximity of substances on voltaic action: Dr. Gore, F.R.S.

Micrometer for microscopic measurement of large objects. Manufactured by the Cambridge Scientific Instrument Co.: Prof. W. F. R. Weldon, F.R.S.

Earth thermometer. A simple apparatus for the determination of earth temperatures: Mr. E. H. Griffiths, F.R.S.

Experiments illustrating a new method of controlling the electric arc in its application to photo-micrography: Mr. T. A. B. Carver and Mr. J. E. Barnard.

Kamm's "Zerograph," or "Printing Telegraph System": Mr. L. Kamm.

New phototheodolite, designed by Mr. J. Bridges-Lee: Mr. Casella.

The following demonstrations, with experiments and lantern illustrations, took place in the meeting-room:—

Experimental demonstration of "some electric and mechanical analogues": Prof. W. E. Ayrton, F.R.S.

Lantern-slides from micro-photographs, illustrating nuclear division in animal and vegetable cells: Prof. J. B. Farmer. Slides were shown illustrating the process of fertilisation and segmentation of the egg in *Ascaris megalocephala*, and in *Fucus vesiculosus*.

INFLUENCE OF RÖNTGEN RAYS UPON ELECTRICAL CONDUCTIVITY.[1]

In a note read on March 1 in the Royal Society of Edinburgh, Lord Kelvin, Drs. Beattie, and Smolan treat of the influence of the Röntgen rays on the conductivity of air, paraffin, and glass (NATURE, vol. lv. pp. 498-99). After careful experiments, made with different potentials, they conclude that no perceptible increase of the conductivity of paraffin and glass is produced on them by the action of the X-rays. On the contrary, Messrs. J. J. Thomson and M'Clelland have thought, after their experiments, that paraffin and glass, submitted to the X-rays, increase conductivity. I had employed myself in the same question some time before, and I have explained the results of my researches in two notes presented to the Royal Academy of Naples on May 9 and July 4, 1896, and in a third note presented to the Royal Academy of the Lincei in Rome on June 6, 1896. This last note begins with the following words:—

"My first idea was to study whether the X-rays, crossing a dielectric, could render it conductor, so as to facilitate across it the discharge of an electrified body. In these researches of mine I employed, as a dielectric, some paraffin because, besides its being one of the best insulators, it is also very transparent to the X-rays."

The results set forth in those three notes may be thus shortly re-stated.

The discharge of a conductor in the air, provoked by the X-rays, seems to take place by convection or transport; so to say by an electric dance of the particles in the air, roused by radiation. Righi's experiments lead likewise to a similar interpretation.

The discharge of the conductor becomes slower when the surface exposed to air is diminished—that is to say, when a portion of it is covered with paraffin.

A conductor, loaded with electricity and narrowly surrounded by a wrapper of paraffin, loses, by a first action of the X-rays, a small part of its discharge, and in the following times, after having been freshly charged to its primitive force, it always loses less, so that at the third, fourth, or fifth experiment the discharge is imperceptible or next to nothing. Therefore paraffin, under the action of the X-rays, does not gain in conductivity.

India-rubber behaves almost in the same manner as paraffin.

If the conductor is surrounded first by air and further out by a tube of paraffin, the conductor excited by the X-rays discharges itself, at first rapidly enough; but, soon after, the discharge proceeds, to the last, very slowly. As usual, electricity, carried by air, soon loads the sides of the tube, and then disperses itself with difficulty.

Electricity, scattered from the body, submitted to the action of the rays, can join itself again on a tube of paraffin, or of insulated metals, surrounding the discharging body. This electricity, gathered up on a tube, can be directly observed with an electroscope provided with dry piles, and is found, as is to be expected, of the same nature as that of the body itself.

Insulating liquids (turpentine oil, vaseline, Venetian turpentine, and petroleum) were also examined by me, and they behaved almost in the same manner as paraffin. An electrified conductor submerged in one of these liquids (vaseline oil is the best of all), under the action of the X-rays, discharges itself at first rapidly, but soon after the discharge stops almost entirely.

Lastly, the conductive property of the gases, crossed by the X-rays, increases with their density, and may be ranged in the following order:—

Hydrogen, lighting gas, air, carbonic anhydride, and vapours of ether or carbonic sulphur.

The results, relative to the first four gases, agree with those already given by Righi.

[1] Experiments published May, June, July 1896, proving that solid and liquid insulators retain their insulating powers under the influence of the Röntgen rays. By Prof. Villari. Communicated by Lord Kelvin.

THE CHEMISTRY OF THE HOTTEST STARS.

At a discussion meeting of the Royal Society, held some two months ago, a paper was read by Mr. J. Norman Lockyer, C.B., F.R.S., under the above title. This has recently been published, and we reproduce the general conclusions.

(1) In a mixture of vapours at a particular temperature, a vapour which is not present in sufficient quantity to show all the lines of its spectrum will be represented by the lines which are longest in its spectrum at the particular temperature in question.

Only some of the short lines in metallic spectra represent the effects of high temperature.

(2) Some of the substances which have been investigated, including iron, calcium, and magnesium, have probably a definite spectrum, consisting of a few lines, which can only be completely produced at a temperature higher than any which is at present available in laboratory experiments. The lines constituting the new spectra are those which either only appear in the spark spectrum, or are lengthened in passing from the arc to the spark. Such lines are termed enhanced lines.

(3) In the case of iron, calcium, and magnesium, there are four distinct temperature steps which are marked by spectral changes: (*a*) the flame spectrum, (*b*) the arc spectrum, (*c*) the spark spectrum, (*d*) a spectrum consisting solely of those lines which are enhanced in passing from the arc to the spark.

(4) The order of temperature of certain stars, as determined from a comparison of the extensions of the continuous spectrum into the violet or ultra-violet, is precisely the same as that which follows from a comparison of the metallic spectra at the four stages of temperature.

(5) The variations of the metallic lines furnish the most convenient means of determining relative stellar temperatures, for the reason that photographs with special exposures are unnecessary.

(6) Having ascertained the relative temperature of a star in this way, and assuming that all the absorbing vapours are at the same temperature, the presence or absence of any other metallic substance can be determined by looking for the lines which are longest in its spectrum at that temperature. In the case of the hottest stars, the fourth stage spectrum must be the term of comparison.

(7) Accepting the new results with regard to the lines enhanced in the spark, several lines in the spectra of the hottest stars, for which no origins could previously be assigned, can now be ascribed to metallic substances at the fourth stage of temperature.

(8) The lines of the cleveite gases appear only in the hotter stars, as indicated by the extension of the continuous radiation into the ultra-violet. They increase in intensity with increased temperature in certain stars.

(9) The order of stellar temperatures, determined from the *increasing* intensity of the lines of the cleveite gases, is identical with that determined from the *decreasing* intensity of the metallic lines in the case of those stars which show both series of lines:

(10) Different substances are spectroscopically visible through different ranges of stellar temperatures. The hydrogen lines are visible in stars ranging in temperature from that of α Orionis to that of Bellatrix, while those of the cleveite gases do not appear below the temperature of α Cygni. The enhanced lines of calcium appear at temperatures as low as α Orionis, and persist, with reduced intensity, to the temperature of Bellatrix; those of iron do not appear at temperatures lower than that of α Cygni, and disappear altogether at the temperature of Bellatrix; while the enhanced line of magnesium appears at the temperature of α Cygni, and remains feebly visible at the temperature of Bellatrix.

(11) It follows, then, that the enhanced metallic lines may be absent from a stellar spectrum, either because the temperature is too low or too high.

(12) In the case of those stars which previous investigations have shown to be cooling, the metallic line phenomena are inverted. The enhanced lines first become visible, then the arc lines; while the enhanced lines disappear at a certain stage in the process of cooling the arc lines continue to become stronger.

(13) The lines of the cleveite gases show a similar inversion on the downward side of the temperature curve. Strongly represented in the hottest stars, they thin out very rapidly in cooling stars, and disappear before the arc lines have begun to show themselves.

(14) Utilising the iron lines as a method of bringing together stars of approximately equal temperature, it is found that at each stage the stars are divisible into two groups, which, in accordance with my previous work, correspond to increasing and decreasing temperatures respectively.

(15) As determined in this way, stars of increasing temperature differ from those of decreasing temperature at the same stage of heat: (1) in the greater continuous absorption in the violet or ultra-violet, (2) in the generally greater intensity and breadth of the metallic lines, (3) in the smaller thickness of the hydrogen lines, (4) in the greater thickness of the helium lines at those stages in which they are visible.

(16) These differences are all explained on the meteoritic hypothesis.

(17) There are stars, near and at the top of the curve, which cannot be arranged in order of temperature by the criteria referred to in (15), for the reason that the iron lines have disappeared, and the lines of hydrogen and cleveite gases show little variation.

(18) The arrangement of stars about the top of the curve will depend upon the conditioning of certain lines, at present of unknown origin; the necessary criteria, therefore, require further investigation.

(19) The known facts with regard to changes in the line spectrum of an element can be easily explained on the hypothesis of successive dissociations analogous to those observed in the case of undoubted compounds.

(20) Similarly, the differences in the lines representative of a metal such as iron in the spectra of sun-spots, prominences, chromosphere, or different stars, are explained by supposing that there are different molecular groupings at each stage of temperature.

(21) The change from a continuous spectrum to one consisting of flutings, and afterwards to one of lines, is now acknowledged to be due to the existence of different molecular combinations.

(22) The recent investigations of Humphreys and Möhler on the shifts produced in metallic lines, when the vapours are observed at different pressures, confirm my view that the line spectrum of a metal integrates for us the vibrations of several sets of molecules.

(23) It is argued that the existence of "series" of lines in the spectra of some chemical elements is another indication of molecular complexity, each series probably representing the vibrations of similar molecules.

(24) The behaviour of the magnesium lines in stellar spectra is ascribed by Dr. Scheiner to differences of temperature, in accordance with my experimental results of 1879.

(25) The experiments on the spectrum of mercury which have been made by Eder and Valenta have revealed variations which according to them favour the dissociation hypothesis.

(26) On various grounds, the view that the differences in stellar spectra represent fundamental differences of chemical composition is untenable. The fact that many stars which are widely separated in space give identical spectra, indicates that they not only contain the same "elements," but that the "elements" exist in the same proportions in all.

(27) On the non-dissociation hypothesis, the action of heat on the sun's chromosphere could not produce such a spectrum as that which we know to be associated with hotter stars, since the relative proportions of different vapours could not be changed. The only change which can be imagined to take place on this hypothesis is a reduction of intensity of all the lines due to reduced pressure.

(28) On the dissociation hypothesis, increased temperature would bring about fundamental changes in the spectrum due to molecular simplifications, and in this way the effect of an increase of temperature on the sun's chromosphere, as indicated by hotter stars, can be predicted, and receives a simple and sufficient explanation.

(29) The disappearance of the enhanced iron lines in the hottest stars, and the simultaneous intensification of the lines of hydrogen, helium, and gas X, bring us face to face with the fact that iron is a compound, into the ultimate formation of which one or all of these gases enters.

(30) The ultimate molecules of the chemical elements discussed in the present paper may be provisionally arranged in the following order of resistance to the effects of temperature:—

$$\left.\begin{matrix}\text{Gas X}\\ \text{He}\end{matrix}\right\}\text{ Doubtful which.}$$
H
Ca
Mg
Fe

(31) Each step in advance which has been made since 1873, has demonstrated more and more that there is really such a "celestial dissociation" going on as that which I then suggested.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The sixth Robert Boyle Lecture of the Junior Scientific Club will be delivered in the Examination Schools, on Tuesday, June 1, at 8.30, by Captain Abney, C.B., F.R.S., who has chosen for his subject "The Scientific Requirements of Colour Photography."

Mr. W. Garstang, Fellow and Lecturer of Lincoln College,

has been appointed Naturalist to the Marine Biological Association, Plymouth.

The Drapers' Company have asked Mr. Jackson, the University architect, to inquire whether, for the sum of 15,000*l*., a new building can be erected to accommodate the Radcliffe (Scientific) Library.

Before the end of the present term an election will be made to the Oxford Biological Scholarship at Naples. Candidates must be graduates of the University, and are requested to send their names to the Linacre Professor of Comparative Anatomy at the University Museum before the end of May.

An examination for Scholarship and Exhibition is announced to take place at Wadham College on December 6. No papers in Natural Science will be set, but in the election to one of the Exhibitions preference will be given to any candidate who shall undertake to read for honours in Natural Science, and to proceed to a Degree in Medicine.

CAMBRIDGE.—The Grace for confirming the resolution of the Syndicate on titular degrees for women was rejected by 1707 votes to 661. The opposition of the majority of the residents has thus been unmistakably endorsed by the non-resident members of the Senate. It is probable that the question of admitting women to the membership of the University, whether by stages or directly, will not again be raised. The suggestion that powers should be obtained enabling the women's colleges to confer degrees on their own students will now have a better chance of calm consideration. The University might long continue to teach and examine the women students, while the titles which have been sought by them as necessary for their professional success might in this way be acquired without endangering the peace of Cambridge as a place of education for men.

Prof. Rücker, Sec.R.S., will give the Rede Lecture on "Terrestrial Magnetism," in the Senate House, on Wednesday, June 9, at noon.

The General Board of Studies propose to establish a University Lectureship in Experimental Psychology, including the physiology of the senses, at a stipend of 50*l*. a year. The appointment will probably be made next month.

Prof. Hughes, F.R.S., and Mr. P. Lake, of St. John's College, are appointed to represent the University at the International Geological Congress to be held at St. Petersburg in the summer.

FIELD-MARSHAL SIR JOHN LINTORN SIMMONS, G.C.B., will distribute the prizes to the students of the Charing Cross Hospital Medical School, on Wednesday, June 2, at 4 o'clock.

MRS. JOSIAH M. FISKE has given to Barnard College, of New York City, one hundred and forty thousand dollars for a new dormitory. Other gifts of considerable aggregate value have also been recently received by the college. Gifts are constantly pouring in on Columbia University; and the new buildings for these two institutions are rapidly rising on the new site on Morningside Heights.

THE following are among recent appointments:—Dr. E. Fischer to be full Professor of Botany in the University of Berne, and Director of the Botanical Gardens there; Dr. G. Jäger to be Assistant Professor of Theoretical Physics in the University of Vienna; Dr. F. Gräfe to be Assistant Professor of Mathematics in the Polytechnic Institute at Darmstadt; Dr. F. Deichmüller, Privat-docent in Astronomy and Observer in the Bonn Observatory, to be Assistant Professor.

THE Lords of the Committee of Council on Education are taking steps to ascertain the number of pupils now receiving secondary education in England in endowed, proprietary, and private schools. It is not proposed to include in the return any pupils who are only receiving instruction in occasional classes or evening schools; and technical institutes (except in so far as they have secondary day schools) and University colleges will fall outside the scope of the inquiry.

IN the House of Lords, on Friday, Lord Norton asked the Lord President whether he hoped to be able to introduce a Bill on secondary education this Session; or, if not, early next year. The Duke of Devonshire replied that he did not entertain any hope that Parliament would be asked to deal seriously with the subject in the course of the present Session. He hoped, however, that there would be laid before Parliament a Bill the main proposals of which were contained in the Bill of last year, so far as they related to secondary education, with some amendments and additions, in order that the general views of the Government might be once more placed before the country, and that the country might be in a position to consider them during the vacation.

SCIENTIFIC SERIALS.

THE most important paper in the numbers of the *Journal of Botany* for April-May is the completion of Mr. I. H. Burrill's very interesting notes on the fertilisation of spring-flowering plants on the Yorkshire coast. A series of careful observations are recorded on the species of the insect-visitors and the frequency of their visits.—Welwitsch's African collections are still affording to Messrs. W. and G. S. West a large number of new species of desmids.

IN the *Nuovo Giornale Botanico Italiano* for April are only two short papers on structural botany.—Sig. I. Baldrati describes the peculiar excrescences (*pellule*) found on the bulbs of certain species of *Allium*, which he decides to be of a foliar character.—Sig. E. Matteucci speaks of the structure of the corky spots in leaves, which are of the nature of lenticels.—The remaining papers are descriptive.

THE papers in the numbers of the *Bullettino de la Soc. Botanica Italiana* for February-April are also mostly descriptive.—Sig. G. Mattej discourses on the red spots found on the leaves and petals of a number of plants, and of the gum-resinous substance which they contain.—Sig. L. Macchiati returns to the vexed question of the peculiar structure of the seeds of *Vicia narbonensis*, which he declares to present marked differences from those of allied species.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 8.—"Kathode and Lenard Rays." By J. A. McClelland, M.A. Received March 15.

The experiments described in this paper have to do partly with kathode, and partly with Lenard rays.

An arrangement is described by which the charge of electricity carried by the kathode rays can be directly measured, and the same method is then applied to the Lenard rays, which are found to carry a similar negative charge.

In one set of experiments the Lenard rays are examined inside the tube, the kathode rays being allowed to fall upon a screen of thin aluminium, and the charge that is carried by the Lenard rays on the further side of the aluminium measured.

In a second set of experiments, a window of oiled silk is placed in the vacuum tube in the path of the kathode rays, and here, again, the charge carried by the Lenard rays outside the tube can be detected and measured.

It can also be shown that there is a negative discharge from the window by placing a plate of ebonite opposite the window, and dusting it over, after exposure, with minium and sulphur. The well-known negative figure is produced on the plate.

The Lenard rays appear to be simply a secondary propagation of kathode rays, produced by the rapid pulsations of negatively charged particles up to the aluminium screen. Measurements of the amount of electricity carried by these charged particles show that the electrostatic effects produced when they are stopped at the screen are sufficient to produce discharge on the further side of the screen, and a secondary stream of kathode rays. All the observed properties of Lenard rays admit of explanation on the theory that, like the kathode rays, they consist of a stream of charged particles.

In the paper an arrangement is described to measure the portion of the current actually carried by the kathode rays in a vacuum tube. With the tube used, even at a pressure at which there was little phosphorescence, a considerable fraction (more than 1/50) of the whole discharge was carried away from the kathode by the negative rays, while at lower pressures these rays carried a large portion of the discharge.

Chemical Society, April 29.—Prof. Dewar, President, in the chair.—The following papers were read:—On the explosion of chlorine peroxide with carbonic oxide, by H. B. Dixon and E. J. Russell. On exploding a mixture of carbonic oxide and chlorine peroxide, less of the carbonic oxide is burnt as the

mixture is the more carefully dried; this result does not favour the view that "nascent" oxygen attacks carbonic oxide more readily than ordinary oxygen.—On the decomposition of iron pyrites, by W. A. Caldecott. The "slime" obtained on crushing auriferous pyritic Witwatersrand conglomerate contains no ferrous sulphide as it leaves the battery, but this substance can be detected in the slime soon after deposition in the dams; ferrous sulphide is also formed when iron pyrites is crushed to an impalpable powder in a mortar. It would thus appear that ferrous sulphide, and not sulphate, is the first decomposition product of pyrites.—Monochlordiparaconic acid and some condensations, by H. C. Myers. Monochlordiparaconic acid, $C_9H_9ClO_2$, is obtained on treating dichlormethylparaconic acid with barium hydroxide.—Corydaline, Part v., by J. J. Dobbie and F. Marsden. On heating corydaline with dilute nitric acid, dehydrocorydaline nitrate $C_{22}H_{25}NO_4,HNO_3$ is formed, and if the action of the acid be pushed further, corydic acid, $C_{14}H_9N(OMe)_2(COOH)_2$, is obtained; on oxidising this with permanganate, at least four different acids are produced.

May 6.—Prof. Dewar, President, in the chair.—The following papers were read:—A Bunsen burner for acetylene, by A. E. Munby. A modified form of Bunsen burner for use with acetylene is described, which has a much greater heating effect than a Bunsen consuming an equal volume of coal-gas instead of acetylene.—The reactions between lead and the oxides of sulphur, by H. C. Jenkins and E. A. Smith. The authors find that Hannay's hypothetical compound, PbS_2O_2, the formation of which was premised in order to explain the reaction between sulphur dioxide and lead, and between air and galena at high temperatures, does not exist. The investigation of other of the reactions of lead salts at high temperatures prove the accuracy of the equations which Dr. Percy gave as the basis of the metallurgy of lead.—X-ray photographs of solid alloys, by C. T. Heycock and F. H. Neville. The authors have applied the fact that some metals, such as sodium and aluminium, are comparatively transparent to X-rays, whilst others, like gold, are opaque, to the investigation of alloys; a thin section is cut from the alloy to be examined, and an X-ray photograph obtained of it. Examined thus, pure sodium shows no crystalline structure, but alloys containing 3-10 per cent. of gold show transparent sodium crystals interspersed with opaque gold crystals. Many other gold-sodium and some aluminium alloys have been examined by this new method.

Entomological Society, May 5.—Mr. Roland Trimen, F.R.S., President, in the chair.—Mr. C. H. Peers was elected a Fellow of the Society.—Mr. J. J. Walker exhibited an earwig, *Apterygida arachidis*, Yersin, new to Britain, and recently found in large numbers in chemical works at Queenborough. It had been probably imported among bones.—Mr. Burr showed a complete series of the British species of Forficulidæ.—Mr. Enock showed eggs of *Stenopsocus cruciatus*, L., containing parasitic larvæ of *Alaptus fusculus*, Hal., the male of which would probably prove to be *Alaptus minimus*, Hal.—Mr. Merrifield exhibited the results of temperature experiments on the pupæ of *Pieris daplidice*, *Melitæa didyma*, and other species. He thought that changes produced by abnormal temperatures might be classed as follows: (1) enhancement or diminution of intensity of colour without alteration in the form of the markings; (2) substitution of scales of a different colour, scattered or in groups; (3) imperfection in the development of scales or their pigment.—Mr. Tutt showed a series of insects collected at Cannes in March, and remarkable for their early emergence.—Dr. Dixey read a paper on mimetic attraction, in which he dealt with the steps by which a wing-pattern, as in South American Pierinæ, could be modified in various directions so as to secure a mimetic result, and with the theories of mimicry put forward by Bates and Fritz Müller.—Mr. Blandford exhibited and discussed series of homœochromatic and mimetic Neotropical species of butterflies, chiefly of Heliconiidæ and Heliconioid Danaidæ. The discussion was continued by Prof. Poulton, who showed similar groups of several genera, remarkable as having been collected and sent to England as examples of a single species, and by the President, and it was ultimately adjourned to June 2.

Geological Society, May 12.—Dr. Henry Hicks, F.R.S., President, in the chair.—The following communications were read:—On the gravels and associated deposits at Newbury (Berks), by E. Percy Richards. After a general sketch of the geology of the Valley of the Kennet, the superficial deposits at and in the neighbourhood of Newbury were described in detail, from observations made by the author during the progress of the main drainage-works in 1894. The author classified the strata which he examined into five groups: (1) The Preglacial Southern Drift; (2) the Glacial Drift (Donnington); (3) the Upper River-gravel; (4) the Lower River-gravel; (5) the Neolithic peat-beds (shell-marl, peat, and loam).—The Mollusca of the Chalk Rock, Part ii., by Henry Woods. The first part of this paper, dealing with the Cephalopoda, Gasteropoda, and Scaphopoda, appeared in the last volume of the *Quarterly Journal* (vol. lii. p. 68). In the new communication the author gave an account of the characters, synonymy, and distribution of the Lamellibranchia: 29 species were recognised, 6 being new. In the concluding part the author compared the fauna of the *Reussianum*-zone (Chalk Rock) in England with that of other European areas, particularly North-West Germany and Saxony. In the latter country the number of species in some groups—particularly Gasteropoda and Lamellibranchia—was much greater than in England; this difference was probably due to the sea having been of less depth than in the English area. It was noticed that the species of Cephalopoda had a much wider geographical distribution than the other groups of the Mollusca. Finally, by a study of the present distribution of the genera—particularly of those which formed the predominating element in the fauna—taken in conjunction with the other characters of the zone, the author arrived at the conclusion that in England the *Reussianum*-zone was probably formed between the depths of 100 and 500 fathoms.

Mathematical Society, May 13.—Prof. Elliott, F.R.S., President, in the chair.—The following communications were made:—On cubic curves as connected with certain triangles in perspective, by S. Roberts, F.R.S.—Determination of certain primes, by F. W. Lawrence.—An analogue of anharmonic ratio, by J. Brill.—An essay on the geometrical calculus (continuation), by E. Lasker.—On the partition of numbers, by G. B. Mathews.—Notes on synthetic geometry, by W. Esson, F.R.S.

Zoological Society, May 18.—Prof. G. B. Howes in the chair.—Mr. Sclater exhibited a plan of the new Zoological Garden attached to the Pará Museum, Brazil, and called attention to the description of it recently published in the "Der Zoologische Garten" by Herr Meerwarth.—Mr. Sclater exhibited the skin of a penguin which he had received in exchange from the Musée d'Histoire Naturelle of Paris as a specimen of *Microdiptes serresianus* (Oust.); and read a note from Mr. Ogilvie-Grant, according to which this specimen was only an immature example of the Rock-hopper penguin (*Eudyptes chrysocome*).—Mr. R. E. Holding exhibited a skull of a Theban goat (*Capra hircus*, var. *thebaica*), and made remarks on the shortening of the skull in this and other domesticated animals.—Mr. G. A. Boulenger, F.R.S., read a paper entitled "A Revision of the Lizards of the Genus *Sceloporus*." From a study of the large mass of material in the British Museum, the author had come to the conclusion that the difficult genus *Sceloporus*, so far as was at present known, consisted of thirty-two species. Nearly all the specimens examined, with the exception of very young ones, had been measured, and their dimensions and the number of scales and femoral pores possessed by each of them were recorded in the paper. One new species (*Sceloporus asper*) was described.—Dr. G. Herbert Fowler read the second of a series of papers on the Plankton of the Faeroe Channel, which dealt with the distribution of *Conchœcia maxima* (a midwater or mesoplankton form), with the European species of *Tomopteris*, and with the distribution of *Tracheloteuthis riisei*.—Mr. Martin Jacoby contributed the second part of a paper on the Phytophagous Coleoptera of Africa and Madagascar. Nine new genera and eighty new species of the families *Eumolpinæ*, *Halticinæ*, and *Galerucinæ* were described.—Mr. W. G. Ridewood read a paper on the structure and development of the hyobranchial skeleton of *Pelodytes punctatus*.—Messrs. Oldfield Thomas and R. Lydekker, F.R.S., contributed a paper on the number of grinding-teeth possessed by the Manatee. From an examination of several specimens of this animal it had been ascertained that the number of its grinding-teeth was not a fixed one, but that it developed a continuous and indefinite number to replace those which had become worn away by the sand which was necessarily present in somewhat large quantities in its food of water-weeds.

Royal Meteorological Society, May 19.—Mr. E. Mawley, President, in the chair.—Mr. F. Gaster, of the Meteorological Office, read a paper by Mr. R. H. Scott, F.R.S., and himself,

on the mean monthly temperatures of the British Isles. The authors dealt with the means of the daily minimum, average, and maximum temperatures for the various months of the year in the twenty-five years 1871-95. They pointed out that there is a great difference between the amount of range of temperature at the coast stations and that recorded inland. The range between January and July amounts to about 16° at coast stations, but to more than 23° at the inland stations. The contrast between the temperature of the air at inland stations and at coast stations at different times of the year is due to the following causes: (1) The constant tendency of the sun to heat the surface of the earth; (2) the equally constant tendency of the earth to radiate its heat into space, both of these being modified greatly by the aqueous vapour and the clouds suspended in the atmosphere; (3) the fact that the solid portions of the earth absorb and reflect heat much more rapidly than the water; and (4) that while the ocean to the westward is of enormous size and great depth, the sea to the eastward is, comparatively speaking, limited in area and shallow, and separates the eastern shores of the British Islands from those of continental Europe by a small distance.—A paper, by Mr. C. V. Bellamy, on the rainfall of Dominica, West Indies, was also read. The author gave an interesting account of the climate of the island, and then discussed the monthly returns of rainfall from twenty-seven stations during the four years 1893-96. The rainy season extends from July to November, the other months representing the dry season. The month of November, 1896, was the wettest on record.

PARIS.

Academy of Sciences, May 17.—M. A. Chatin in the chair.—On the photographic atlas of the moon, published by the Observatory of Paris (second part), by MM. Lœwy and Puiseux.—Signification of appendices and their symmetry in the measurement of gradation in vegetable species, by M. Ad. Chatin. Plants are classified into two large groups, according as they have appendices or not. The symmetrical relations between the appendices serve to further subdivide the larger series.—Fourth note on the applications of radioscopy to the diagnosis of diseases of the thorax, by M. Ch. Bouchard. The preceding notes deal with the applications of radioscopy to the diagnosis of pleurisy, pulmonary tuberculosis, and hypertrophy of the heart. In the present note four cases are described: one of cancer of the œsophagus, and three of diseases of the aorta subsequent to acute rheumatism, in all of which the examination by the Röntgen rays proved to be of great service.—Demonstration by the Röntgen rays of the osseous regeneration in man after surgical operations, by M. Ollier. Studies of this nature have hitherto been very difficult, owing to the fact that accidental deaths at suitable stages in the osseous development are necessarily rare. The form and dimensions of the osseous masses in the new formation can now be readily demonstrated by means of the X-rays. The exact knowledge afforded in this way of the position of diseased bone (as in osteo-myelitis), renders unnecessary the immediate amputation of the limb, since the whole of the diseased portions can be removed with precision.—Disturbances in lakes and hurricanes, by M. F. A. Forel. It is shown that sudden barometric changes of the order of magnitude actually registered on one or two occasions are sufficient to account for the extraordinary changes of level occasionally observed on the Lakes Leman and Geneva. The effects are magnified by interference, and by the narrowing down of the lake.—M. Klein was elected a Correspondant of the Academy in the Section of Geometry, in the place of the late Prof. Sylvester.—Converse theory of binomial theorem, by M. Sitanath Chakrabarthy.—On the medicinal properties of *Œnothera biennis*, by M. Lewis Germain.—On the curves of which the tangents belong to a complex, by M. A. Demoulin.—On some applications of the theory of cyclic systems, by M. C. Guichard.—On a graphical method of integration for differential equations, by M. Michel Petrovitch. A mechanical apparatus is described capable of integrating all equations of the form $\Phi(y)\, dy/dt + \lambda \sqrt{y} - af'(t) = 0$, and of certain other equations derived from this by suitable substitutions.—On the kathode rays and some phenomena in vacuum tubes, by M. C. Maltézos. Experiments are described leading to the conclusion that anode light consists of matter carrying positive electricity.—On the transparency of ebonite, by M. Perrigot. Ebonite in thin films (0·5 mm.) is obviously transparent to red light, and light after passing through ebonite produces distinct effects upon orthochromatic plates rendered sensitive to the red and yellow rays. Ebonite plates 2 mm. in thickness, although opaque to the eye, still affect the photographic plate. These results confirm those of M. Becquerel as to the true cause of the effects observed by M. Le Bon.—New determinations of gravity, by M. J. Collet. The results of a series of pendulum observations along the forty-fifth parallel of latitude. The final results are compared with those calculated by Defforges' formula, the experimental results being always slightly lower than the theoretical.—On lithium borate, by M. H. Le Chatelier. The monoborate $LiBO_2$ is readily obtained in the dry way; it dissolves, readily forming the hydrate $LiBO_2 8H_2O$. The solubility curve shows some peculiarities, there being a temperature of maximum solubility. The heats of hydration, solution, and combination were determined. In the wet way, a diborate analogous to borax is formed, but the salt is so soluble that it could not be isolated.—On the alloys of the silver-copper group, by M. F. Osmond. In spite of the fact that the alloy containing the metals in the proportions indicated by Ag_3Cu_2 is the only one that does not liquate on solidifying, the alloy is not a homogeneous compound, but a mixture. The results of Heycock and Neville on the melting points of the copper zinc alloys indicate this, and the micrographical study affords results leading to the same view.—Researches on the coloration of glass by the direct penetration of metals or metallic salts, by M. Léon Lémal. Glass of a suitable composition can be coloured by a process similar to cementation at temperatures between 500° and 550° C. With silver salts a reddish orange stain is produced.—Remarks by M. Armand Gautier on the preceding note.—The action of water upon phosphoryl trichloride, by M. A. Besson. By the action of small quantities of water upon $POCl_3$ at 100°, several chlorides appear to be produced, from which pyrophosphoryl chloride, $P_2O_3Cl_4$, can be isolated and analysed in a fairly pure state. The residue is stated to consist of metaphosphoryl chloride, but no analyses are given, nor any indications that the residue was a homogeneous substance. The action of water is thus shown to be analogous to that of hydrogen sulphide.—On some new symmetrical aromatic ureas, by MM. P. Cazeneuve and Moreau. The authors conclude from their experiments that the best method of preparation of symmetrical substituted ureas is by acting with primary bases upon the carbonic ethers of the phenols, especially upon the carbonate of guiacol.—On the amido-amidines, by M. Charles Lauth.—*Rôle* of tannins in plants, and especially in fruits, by M. C. Gerber. One of the chief functions of tannin appears to be to prevent pectic transformations, and hence to prevent the fermentation of their sugars. In fruits containing tannins, these disappear completely by oxidation without giving rise to any carbohydrates.—On the *Pseudocommis vitis* (Debray), and on new proofs of the existence of these Myxomycetes, by M. E. Roze.—The clear rings ("lunure") in sections of oak wood, by M. Emile Mer.—Physiological disturbances due to the X-rays, by M. Destot. The differences between the effects of exposure to the sun and X-rays are clearly marked, the latter not being felt at the moment of application, and only becoming evident after a considerable time.—Researches on the causes of disturbances due to growth with the aid of the X-rays, by MM. Maurice Springer and D. Serbanesco.—Rule for solving two numerical equations of any degree with two unknowns, by M. Teguor.

ST. LOUIS.

Academy of Science, May 3.—Mr. H. von Schrenk spoke of the respiration of plants, with special reference to the modification of those growing with their roots submerged in water. The lecture was illustrated by a demonstration of the liberation of carbon dioxide in respiration from the roots of an ordinary flowering plant and freshly gathered fungi, and the more usual ærenchyma structures were made clear by the use of lantern slides.—Prof. F. E. Nipher described a simple means of measuring the resistance of a tube to the flow of air, when compared with an accepted standard, by the use of a tubular device, similar in principle to the Wheatstone bridge used in electrical instruments; the apparatus, in the present instance, consisting of parallel tubes filled with air, connected by a tubular bridge, in the middle of which a drop of water was placed, so as to change position with the variations in the flow of air on the one hand or on the other.

AMSTERDAM.

Royal Academy of Sciences, April 21.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Haga communicated a method of determining the wave-length of X-rays. This method,

the result of experiments made by Mr. P. G. Tiddens, of Gröningen, is founded upon the fact that a perfectly identical deflection image is produced by rays of very different wave-length, by varying the distance between the source, the diffracting slit, and the screen in a definite manner. Starting from a diffraction image of light rays, provisional experiments were made to determine whether the wave-length of X-rays was equal to, or one-quarter or one-fifteenth of, that of light rays. In the last-mentioned case, the image resembled that obtained from light rays more than the others did; it was not, however, quite identical with it —Prof. Haga read a paper, by Dr. C. H. Wind, on the influence of the dimensions of the light beams on Fresnel's diffraction phenomena, and on the diffraction of X-rays. From experiments, made by Mr. Tiddens, it appeared that the X-shadow figures obtained by Fomm and others, are not ordinary Fresnel diffraction images. The author showed that the shadow figures obtained are to be conceived as secondary diffraction images (arising from ordinary ones on the slit serving as a source of light being widened), and he developed the main points of the theory of these secondary diffraction images, and pointed out the way it opens to determining the wave-length. The existence of secondary diffraction phenomena, analogous to those observed when employing X-rays, can easily be ascertained when ordinary light is used. This, in the author's opinion, as good as proves the undulatory character of X-rays.—Mr. Hamburger communicated a new quantitative method of determining the anti-bacterial action of blood and tissue fluid. This method avoids the usual counting of microbes with the help of plate cultures, because this occasions errors of 40 to 50 per cent. Instead of counting the microbes, their total volume is determined by centrifugal action. This method occasioned errors of only 6·5 per cent.—Prof. van der Waals presented, for publication in the *Proceedings*, a paper on the equilibrium of a compound solid in the presence of a gas and a liquid. The author proves that by adding to the ψ surface for a mixture (*Arch. Néerl.*, t. xxiv.) a ψ line for the solid, the laws of these phenomena can be deduced in a simple way by geometrical construction.

DIARY OF SOCIETIES.

THURSDAY, MAY 27.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, MAY 28.

ROYAL INSTITUTION, at 9.—The Isolation of Fluorine: Prof. H. Moissan.
PHYSICAL SOCIETY, at 5.—The Perception of Difference of Phase by the Two Ears: Dr. A. A. Gray.—The Isothermals of Isopentane: Mr. Rose-Innes.

SATURDAY, MAY 29.

LONDON GEOLOGICAL FIELD CLASS.—Excursion to Sheerness. Drive to East Church, Hensbrook. London Clay. Leave Holborn Viaduct, 1.25.

MONDAY, MAY 31.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Nupe and Ilorin (Nigeria): Lieut. Seymour Vandeleur.

TUESDAY, JUNE 1.

ROYAL INSTITUTION, at 3.—The Heart and its Work: Dr. E. H. Starling.
ZOOLOGICAL SOCIETY, at 8.30.—On the Structure of the Skull in the Paraguayan Lepidosiren: Prof. T. W. Bridge.—On the Classification of the *Thyrididæ*, a Family of the Lepidoptera Phalænæ: Sir George F. Hampson, Bart.—On a Collection of Lepidoptera obtained at Shoa in 1894 by Mr. F. Gillett: Dr. A. G. Butler.

WEDNESDAY, JUNE 2.

ENTOMOLOGICAL SOCIETY, at 8.
VICTORIA INSTITUTE, at 4.30.—Annual Meeting.—Address by Lord Kelvin.

THURSDAY, JUNE 3.

ROYAL SOCIETY, at 4.—Election of Fellows.——At 4.30.—*Probable* Papers: The Sensitiveness of the Retina to Light and Colour: Captain Abney, F.R.S.—On the Mechanism by which the First Sound of the Heart is produced: Sir R. Quain, F.R.S.—Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races: Miss Alice Lee and Prof. K. Pearson, F.R.S.—An Investigation on the Variability of the Human Skeleton, with especial reference to the Naquada Race, discovered by Prof. Flinders Petrie in his Explorations in Egypt: E. Warren —On the Brains of Two Sub-Fossil Malagasy Lemuroids: C. I. Forsyth Major.—(1) On the Dielectric Constants of certain Frozen Electrolytes, at and above the Temperature of Liquid Air; (2) On the Dielectric Constants of Pure Ice, Glycerine, Nitrobenzol, and Ethylene Dibromide, at and above the Temperature of Liquid Air: Prof. Fleming, F.R.S., and Prof. Dewar, F.R.S.—Preliminary Communication on the Nature of the Contagium of Rinderpest: A. Edington.
LINNEAN SOCIETY, at 8.—Observations on Termites: Dr. G. D. Haviland. —On the Genus Ramulina: Prof. T. Rupert Jones, F.R.S., and F. Chapman.
CHEMICAL SOCIETY, at 8.—On the Thermo-chemistry of Carbohydrate Hydrolysis; On the Thermal Phenomena attending the Change in Rotatory Power of Freshly-prepared Solution of certain Carbohydrates, with some Remarks on the Cause of Multirotation: Horace J. Brown, F.R.S., and Spencer Pickering, F.R.S.—Optical Inversion of Camphor; Derivatives of Camphoric Acid. Part II. Optically Inactive Derivatives; Racemism and Pseudo-racemism: Dr. F. S. Kipping and W. T. Pope.—On some New Gold Salts of the Solanaceous Alkaloids: Dr. H. A. D. Jowett.

FRIDAY, JUNE 4.

ROYAL INSTITUTION, at 9.—Signalling through Space without Wires: W. H. Preece, C.B., F.R.S.
GEOLOGISTS' ASSOCIATION, at 8.—The Origin of the High-Level Gravel with Triassic Débris adjoining the Valley of the Upper Thames: H. J. Osborne White.

SATURDAY, JUNE 5.

GEOLOGISTS' ASSOCIATION—Excursion to Cheltenham and Stroud. Leave Paddington at 10.32 a.m.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Ride through Western Asia: Clive Bigham (Macmillan).—A Text-Book of Geology: W. J. Harrison, new edition (Blackie).—A Handbook to the Order Lepidoptera: W. F. Kirby. Vol. v. Moths, Part 3 (Allen).—Uber Verwachsungsversuche: Prof. G. Born (Leipzig, Engelmann).—Year-Book of the Scientific and Learned Societies, 14th annual issue (Griffin).—Catalogue of Tertiary Mollusca in the Department of Geology, British Museum (Natural History): G. F. Harris, Part 1 (London).—Catalogue of the Fossil Cephalopoda in the British Museum (Natural History): Dr. A. H. Foord and G. C. Crick, Part 3 (London). —The Concise Knowledge Natural History (Hutchinson).—Harrow Butterflies and Moths: J. L. Bonhote and Hon. N. C. Rothschild, Vol. 2 (Harrow, Wilbee).—L'Évolution Régressive en Biologie et en Sociologie: J. Demoor, J. Massart, and E. Vandervelde (Paris, Alcan).
PAMPHLETS.—Annual Report of the Geological Survey of the United Kingdom: Sir A. Geikie (Eyre).—Vergleichende Studien über das Seelenleben der Ameisen und der Höhern Thiere: E. Wasmann (Freiburg in Bresgau, Herder).
SERIALS.—Zeitschrift für Physikalische Chemie, xxii. Band, 4 Heft (Leipzig, Engelmann).—Geological and Natural History Survey of Minnesota, 22nd and 23rd Annual Reports (Minneapolis).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1896, Part 3 (Philadelphia.) —Maori Art, Part 1 (Wellington, N.Z.).—Good Words, June (Isbister).—Sunday Magazine, June (Isbister).—L'Anthropologie, Tome viii. No. 2 (Paris, Masson.—Essex Institute Historical Collections, Vol. xxxii. (Salem, Mass.).—Longman's Magazine, June (Longmans).

CONTENTS.

THURSDAY, JUNE 3, 1897.

ROCK-WEATHERING.

A Treatise on Rocks, Rock-weathering and Soils. By George P. Merrill, Curator of Geology in the U.S. National Museum. Pp. xx + 411. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

"THE ruins of an older world are visible in the present structure of our planet; and the strata which now compose our continents have been once beneath the sea, and were formed out of the waste of pre-existing continents. The same forces are still destroying, by chemical decomposition or mechanical violence, even the hardest rocks, and transporting the materials to the sea, where they are spread out, and form strata analogous to those of more ancient date." These memorable words of Hutton, written more than a century ago, have been appropriately selected by the author as the motto for his work, the main object of which is to describe the various processes of rock degeneration and soil formation.

The book is divided into five parts, dealing with the constituents of rocks, the different kinds of rocks, the weathering of rocks, the transportation and re-deposition of rock débris, and the mantle of unconsolidated material which covers the greater portion of the land surface, and for which the author proposes the term "regolith."

The first two parts are not remarkable, either on account of the matter contained or the mode of treatment. The author somewhat disarms the critic, so far as these parts are concerned, by stating in the preface that "the work must be considered in no sense a petrology, as this word is commonly used"; nevertheless, we feel justified in pointing out that much which is inserted might have been omitted without detriment to the work so far as its main object is concerned, and much that is omitted might appropriately have found a place. Thus the first part contains scraps of information about the characters of rock-forming minerals, which are insufficient for the beginner, and are not required by the advanced student. More serious are the omissions. In a work dealing with the disintegration and decomposition of rocks, we naturally look for a somewhat detailed account of the pathological characters of the primary constituents of the crystalline rocks, and of the physical and chemical conditions under which the various secondary products arise. Very little information is, however, given on these points; and this is all the more remarkable, because the works of Roth, and the numerous and important papers by Lemberg, referred to by the author, would have readily supplied him with a large amount of the necessary material.

The classification of rocks adopted by the author is simple, natural, and well suited to his purpose. The igneous rocks are divided into nine groups, depending mainly on chemical composition, and are defined by taking the plutonic and volcanic representatives of the several groups. Thus we have the granite-liparite group, the foyaite-phonolite group, the gabbro-basalt group, and so on. The author does not favour the modern tendency to introduce new names for comparatively unimportant local varieties, and protests against "such monstrosities of nomenclature as ovachichite, monchiquite, yogoite, and absarokite."

The descriptions of the rocks are generally accurate, but we have noted one or two imperfections. Thus the statement that "chert is an impure flint, containing not unfrequently nummulitic remains," appears somewhat strange when one remembers that cherts are of all ages, and that they are largely due to accumulations of sponge spicules and radiolaria.

The unpleasant task of fault-finding ends with the consideration of Part II. In the remaining parts which make up the main body of the work we have an admirable presentation of the various phenomena connected with the disintegration and decomposition of rocks, the transportation of rock-débris, and the formation of soil. Part III. deals with weathering. The action of the atmosphere, the chemical action of water, the mechanical action of water and ice, and the action of plants and animals, including the nitrifying organism, are severally discussed in detail. Then follows a special chapter, based largely on the author's original work, and containing some hitherto unpublished material, in which special cases of decomposition are described. The cases have been carefully selected, chemical analyses of the fresh and decomposed rocks are given, and these are supplemented by mechanical analyses of the latter. In a few instances, chemical analyses of the different parts into which the decomposed rock can be separated by mechanical means are also given. This exhaustive study necessarily brings out a number of points of great interest, only one or two of which can be referred to.

To illustrate the method of treatment, we quote below a table representing the analyses of fresh and decomposed gneiss from Albemarle County, Virginia—that is, from a region outside the area of glaciation, and one in which the rocks have, therefore, been subjected for a long period to atmospheric influences.

—	I. Bulk analysis of fresh gneiss.	II. Bulk analysis of decomposed neiss.	III. Loss.	IV. Percentage of each constituent saved.	V. Percentage of each constituent lost.
Silica	60·69	45·31	31·90	47·55	52·45
Alumina	16·89	26·55	0·00	100·00	0·00
Ferric oxide	9·06	12·18	1·30	85·65	14·35
Lime	4·44	trace	4·44	0·00	100·00
Magnesia	1·06	0·40	0·80	25·30	74·70
Potash	4·25	1·10	3·55	16·48	83·52
Soda	2·82	·22	2·68	4·97	95·03
Phosphoric acid (P_2O_5)	0·25	·47	0·00 [1]	100·00	0·00 [1]
Ignition	0·62	13·75	0·00 [1]	100·00	0·00 [1]
	100·08	99·98	44·67	—	—

A comparison of the bulk analyses of the fresh rock, and the incoherent material resulting from its decomposition, necessarily gives, in many cases, a very imperfect

[1] Gain.

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idea of the change which has taken place. Some constituents are readily removed; others, especially the alumina, are comparatively insoluble under ordinary conditions, and therefore remain behind. Thus, Columns III., IV. and V. show the loss or gain of the various constituents estimated on the basis of constant alumina. We may remark, in passing, that alumina may be removed under certain conditions; as, for example, when sulphuric acid is formed by the oxidation of pyrites. This shows the necessity of caution in taking alumina as the basis of comparison, but it does not affect the present case. From Column III. we learn that 31 per cent. of silica, 1·3 of ferric oxide, the whole of the lime, and the greater part of the magnesia and alkalies have been removed. The total loss amounts to 44 per cent. In this case, the breaking down of the rock has been accompanied by decomposition as well as disintegration; in other cases decomposition is not so prominent, and the total loss is consequently much less.

Many rocks are treated in the same way, but one other illustration must suffice, and for the complete data in this case we must refer the reader to the book itself. In certain parts of America, and indeed in all countries where limestones are extensively developed, and where the residual products of decomposition are allowed to accumulate for a considerable length of time, a superficial deposit of red or brown clay is formed. In these cases the author considers that silica may be assumed to be constant, and taken as the basis for calculating the amount of material removed. He thus arrives at the conclusion that in the particular case described by him 97 per cent. of the original limestone has disappeared. In some localities residual clays of this kind attain a thickness of from 20 to 120 feet.

Having considered in detail a number of special cases in the manner above described, the author proceeds to deal with the influence of joints of texture, of mineralogical composition, of climate, and many other factors. All these points are discussed in the light of recent knowledge, and the chapters devoted to them are full of interesting and important information. Illustrative cases are mostly drawn from American sources, and this gives to the book a refreshing novelty, at any rate to English readers, even when well-known principles are treated. Especially interesting are those portions dealing with climate. It is pointed out that in cold and dry climates, subject to extremes of temperature, disintegration is the dominant factor; whereas in moist, warm climates decomposition is very pronounced. Thus the careful study of the petrographical character of sediments may be expected to throw important light on the climatic conditions of those regions which furnished the material. This point is, of course, not new; but its importance has not been fully recognised, and it is therefore satisfactory to see that the author gives it a prominent place.

The concluding part of the book deals with the superficial deposits for which the term regolith is proposed. Under this term is included not only the soil, subsoil and residual products of decomposition, but also the alluvial, æolian, and glacial deposits. We are by no means convinced that the author was well advised in departing from his general and most praiseworthy determination to avoid as much as possible the introduction of new terms; but the point is, after all, of comparatively slight importance. If the term supplies a want, it will come into general use; if not, it will die out.

The petrographical characters and conditions of formation of the various deposits classed as the regolith are described, and we are glad to see that special attention is paid to the æolian formations, as these often receive scant courtesy at the hands of geologists. Loess, however, is discussed under alluvial deposits, although it is ascribed in part to the action of the wind. Surely there can be no doubt that typical loess is of æolian origin; and if, in America or elsewhere, alluvial deposits have been included under this term, this should be recognised as a mistake, and speedily rectified.

The work is admirably illustrated by twenty-five plates and numerous figures in the text, all of which have been produced in the manner so highly appreciated by those who are acquainted with American geological literature.

MECHANISM AND BIOLOGY.

Zeit- und Streitfragen der Biologie. Heft 2. *Mechanik und Biologie.* Von Prof. Dr. Oscar Hertwig. Pp. iv + 211. (Jena: Gustav Fischer, 1897.)

FROM the title of this work one might have expected a critical examination of the validity of the general principles of modern biology, more particularly of modern physiology; and such a criticism, from the pen of Dr. Oscar Hertwig, would have been welcome and instructive. It is with a feeling of disappointment that one finds that his criticism is almost entirely confined to a comparatively limited aspect of the question, and is, in fact, a polemical treatise directed especially against the pretensions and conclusions of Wilhelm Roux and his school. It is, no doubt, a simpler task to refute the theories of Roux; but if Dr. Oscar Hertwig is victorious in this particular argument, it must not be supposed that he has weakened, or that he has even attempted to weaken, the conviction held by the majority of biologists, that the explanation of vital processes is to be sought for on "mechanical" principles. There is, however, a considerable amount of obscurity attached to this word "mechanical" as applied to biological phenomena, and many pages of this book are devoted to pointing out the errors into which we may be led if we use the word in a loose and general sense, or if we confuse its philosophical with its physical meaning. In its widest sense a mechanism is a system of objects, which in place and time stand in a necessary relation to one another. Hence, when we describe the attitude of contemporary science as mechanical, we do but assert that science is convinced that the operations of nature are subject to the control of universal law. Of this the biological are as much convinced as the abiological sciences; yet this conviction does not necessarily lead to the conclusion that the methods of the abiological are in all respects applicable to the biological sciences. To discuss this question is to discuss the philosophical basis not only of biology, but of all the sciences. As a contribution to the discussion, Dr. Hertwig gives us copious quotations from Spinoza, Kant, Lotze and other philosophers, skilfully selecting such passages from these thinkers as best serve his immediate purpose of refuting Roux. His readers

would have profited had he taken a more detached view of his subject, and had attempted to define the grounds of our belief in the prevalence of universal law in biological phenomena without special regard to Roux or any other author.

In the second part of this book, Dr. Hertwig deals with the methods of developmental mechanics as put forth by Roux and his school. Roux is one of those who specially represents a modern tendency to magnify the importance of experiment in biological investigation, and to minimise the value of what is called "mere observation." It has been pointed out, over and over again, that there is no sharp distinction between experiment and observation, that some of the most complete, the most "mechanical" of the sciences—as, for example, astronomy—are, from the nature of things, sciences of observation, and that what we call experiment is but a means to an end, the end in every case being observation of the change of state following the disturbance which was the first step introduced by the experiment. Here, says Dr. Hertwig, there is a great difference between the inorganic and the organic world. Inorganic substances are relatively stable; the simple contemplation of them would lead to no result. It is only by disturbing their condition of equilibrium, by causing changes of state in them, that we can observe a succession of phenomena which will enable us to assert relations of cause and effect. With living things the case is different; they are in a constant state of flux, and observation presents us with an unbroken succession of changes whose laws may be traced by the aid of reflection. What is true of biology in general is especially true of the study of the development of organisms, since it is during their development that organisms exhibit the most numerous, the most constant, and the most unbroken succession of changes. In depreciating the results of observation, and in drawing a brilliant picture of the results which are to follow from the use of experiment in biology, Roux, and those who, like Yves Delage, have followed him, have fallen into the error of supposing that observation is necessarily an act of contemplation without reflection, and that reflection added to observation raises the last-named to a level which has neither been attained nor sought after by the majority of workers. Such an error is easily refuted by Dr. Hertwig, who shows that in the domain of embryology the method of observation has been strikingly fruitful of results; that embryologists have been distinguished for the readiness, sometimes by the over-eagerness, with which they have drawn conclusions as to cause and effect from the results of their observations; and, finally, that the much-praised method of experiment, when applied to embryological research, has been comparatively barren of result. We have, indeed, learnt some new and striking facts from the experiments of Driesch, Wilson, Zoja, and of Hertwig and Roux themselves; but the main result of these experiments has been to overthrow the speculations of the school which plumes itself on its insight into the mechanical processes of development.

To most persons the most interesting part of Dr. O. Hertwig's book will be the appendix, which contains critical observations on the mechanical laws of development promulgated by Roux. This author, it will be remembered, as a result of experiments and observations, made by him on the developing ova of the frog, formulated a series of developmental laws, of which the chief were: that the plane of the first segmentation coincides with the sagittal plane of the future embryo; that the four first blastomeres correspond to four definite regions, right and left anterior and right and left posterior of the future embryo; and so forth. From these so-called laws theoretical conclusions of wide applications have been drawn. It has been asserted that the organs and tissues of the adult are represented by equivalent ultra-microscopical particles in the ovum, and that these particles are distributed in the ovum in a manner corresponding to their prospective situation in the adult. The particular manner in which these hypothetical particles give rise, in the course of development, to the tissues and organs of the adult, is set forth in Roux's theories of self-differentiation and mosaic-work. Dr. Oscar Hertwig deals in detail with the developmental laws of Roux and their consequences, and shows that, in the first place, the laws have no validity, and that, therefore, in the second place, the conclusions drawn from them are without foundation. Roux destroyed one of the first two or four blastomeres of the frog's ovum, and stated that the embryo resulting from the development of the remaining blastomere or blastomeres was a half embryo or quarter embryo, deficient in those parts which were contained in the blastomeres which had been destroyed. Hertwig, repeating the same experiments, showed that destruction of any of the earliest blastomeres does not, in fact, lead to the results which were described by Roux, and that the early blastomeres might be, so to speak, shuffled up by means of pressure, and yet a perfectly normal embryo be formed. Hertwig's experiments are confirmed by those of Driesch, Wilson and Zoja, who have shown that if the first four blastomeres of echinoderms, of amphioxus, or of hydromedusæ are separated from one another, each gives rise to an embryo, normal in all respects, except that it is a quarter of the usual size. Such experiments point conclusively to the fact that the material of the egg is not qualitatively, but quantitatively divided in the first stages of segmentation, and that Roux's theories of mosaic-work and self-differentiation are, therefore, without foundation. In the appendix to this book the experiments and conclusions of Roux, and the conflicting observations of Hertwig, Driesch and others, are given in a concise and easily intelligible form; and the reader will hardly fail to be persuaded that the balance of evidence is in favour of Hertwig's opinion. At the same time, it must not be forgotten that there is a considerable mass of evidence in favour of Roux's main proposition, that in *normal* development the first segmentation planes do mark out particular regions of the future embryo. Dr. Hertwig has handled Roux somewhat severely for his definitions of normal and abnormal development; but the truth seems to be this. That the ovum of any animal, if left to itself, will go through a course of development which may be called normal, of which one of the features is that the symmetry of the adult is expressed by the earliest cleavage planes. But this course of development, though normal, is not *necessary*. If the blastomeres be displaced, or even if they be separated, development will complete itself, and the end result is the same, though the first steps have been different. The conclusion is that

developing organisms, like adults, are possessed of considerable powers of adaptability. Exposed, for the most part, to very similar conditions, they develop in a very similar way, which we come to recognise as the normal way. But, if the conditions are varied within certain limits, the developing organism adapts itself to those changes, and completes the cycle of its existence. All the evidence, whether from the side of Roux, or from that of Hertwig, Driesch and others of the same opinions, shows that there is a very definite limit to the disturbances to which the developing ovum is capable of adapting itself. Such discussions as are contained in this book only serve to bring forward more prominently the view that the organism is the result of the interaction between its own specific nature and the environmen It would seem that the next essential step in biological inquiry is to determine in special instances what is the nature of the reaction of living substance to external conditions. Much has been attempted in this direction, but the results have hitherto been indefinite, and even contradictory.

THE EXAMINATION OF THE BLOOD IN DISEASE.

A Guide to the Clinical Examination of the Blood for Diagnostic Purposes. By Richard C. Cabot, M.D. With coloured plates and engravings. Pp. xix + 405. (London, New York, and Bombay: Longmans, Green, and Co., 1897.)

SINCE Hughes Bennett's observations on leucocythemia were recorded, great advances have been made in the methods of examining blood, and a certain limited number of physicians, appreciating the importance of the changes that take place in the blood as indicative of changes in the more fixed tissues, have laid considerable stress on the necessity of determining the exact constitution of the blood in certain forms of disease. With all this, however, the use of the various apparatus devised for such estimations have never come into general use. For this there appear to have been two principal reasons: (1) that the medical man has not considered that the information to be derived from such examination is at all commensurate with the time and skill required to obtain such information; (2) the second reason, which, however, is intimately bound up with the first, is that hitherto we, in this country at any rate, have been beholden for any systematic account of the pathology and clinical pathology of the blood to Hayem in France, and to Grawitz, Schmaltz and Rieder in Germany, as up to the present there has been no systematic treatise in the English language on the clinical examination of the blood. Indeed, in recent years, although much valuable work on the blood of animals artificially treated has been published by a number of our younger physiologists and pathologists, and although Gower's work has formed the basis of much of the clinical examination that has been done, it is to the impetus that Metchnikoff and Ehrlich have given to the study of the blood as a histological tissue that these advances have been made. A similar impulse seems to have been given in America, with the result that there has come from the Johns Hopkins Laboratories a work which, whilst based on the researches carried out in France and Germany, has nevertheless a certain individuality and value quite apart from that reflected in it from foreign workers. Dr. Cabot, approaching the subject from the point of view of a man who has made himself thoroughly familiar with the various methods of examining blood, having already examined the blood from nearly a thousand cases, and has at his command the observations on about three thousand more cases examined in the Massachusetts Hospital, gives an account of the structure of the blood, in which, however, it is evident that Ehrlich's observations have been made the basis of the descriptions, as outside Ehrlich's classification the accounts of the structure and appearance of the corpuscles are somewhat meagre, especially from the purely clinical point of view. In the accounts of the systematic work this is, perhaps, not altogether a disadvantage; still we think that those who come to compare this work with the results that they may obtain, either in clinical or in experimental work, will find that full use has not been made of more recent investigations, especially those that have been carried on in this country.

It is impossible, in a short review, to give more than a very meagre outline of this work; but, as it is really the first of its kind that has appeared in the English language, it may be well to indicate the enormous amount of matter that has been collected and arranged in handy form for reference. In the first instance, the methods of clinical examination of the blood are set forth, and from the completeness and accuracy of the descriptions given, and from the fact that the author is so frequently able to indicate the difficulties met with, and the methods of getting over them, it is evident that he has a thorough practical acquaintance with his work. We are glad to see that he insists very strongly upon the examination of the fresh blood—a method of examination which is far too little used in these investigations. The instruments recommended are all of German origin, and the difficulty that has hitherto been found by those working with these instruments are acknowledged. What strikes one very forcibly in this connection is the value of the "Tintometer" system as compared with any of those here mentioned. In describing the myelocytes—the non-motile marrow cells with their large, simple nuclei—Dr. Cabot appears to assign to mere mechanical conditions the regularity of the nucleus, and he says that "the absence of amœboid motion, and of journeys through tissues, leaves the nucleus evenly and moderately stainable throughout, while the amœboid blood leucocyte, through the wear and tear of its migrations, gets its chromatin irregularly distributed, condensed here, pulled out thin there, and hence stains unevenly or is mottled." This point is referred to on several occasions throughout the book. Surely the want of amœboid motion is indicative of the inactivity of the cell, the regularity of the nucleus pointing to the fact that it is in the so-called resting-stage, especially as it is indicated that marked degenerative changes may be observed in these myelocytes. We should feel strongly inclined to reverse Dr. Cabot's cause and effect. After an account of the methods of clinical examination and the physiology of the blood, several chapters are devoted to the general pathology of the blood, after which the bulk of the book is devoted to the special pathology of the blood, primary anæmias, leuk-

æmia and Hodgkin's disease being also very fully treated. Then the blood in acute and chronic infectious diseases, in diseases of special organs, in diseases of the nervous system, constitutional diseases and hæmorrhagic diseases, in malignant diseases in various positions, and, lastly, the blood in which parasites are present. We may take, as an example of the plan of the work, a short description given of the diagnostic value of blood examination in typhoid fever, in which Dr. Cabot notes post-febrile anæmia, sometimes very intense; no leucocytosis; later leucopenia; increased percentage of young leucocytes at the expense of adult forms, especially marked in this late period; most complications cause leucocytosis. Typhoid can be differentiated from local inflammatory processes by the fact that in uncomplicated conditions leucocytosis is never associated with it, whilst all local inflammatory conditions are accompanied by leucocytosis. Typhoid and malaria can, of course, be distinguished by the presence of the malarial organism in one, and its absence in the other. Even in acute tuberculosis, where leucocytosis is not present, the proportion of young leucocytes is, as a rule, larger in typhoid than in tuberculosis. A similar application of this method to other diseases promises excellent results, and we congratulate Dr. Cabot on having placed such a systematic and practical work in the hands of the medical and scientific worker, as we believe that a book of this kind will do more to encourage the study of the pathological conditions of the blood than anything that has appeared in recent years.

OUR BOOK SHELF.

The Forcing-Book: a Manual of the Cultivation of Vegetables in Glass-houses. By L. H. Bailey. Pp. xiii + 266. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THIS is a small manual devoted to an explanation of the principles, and to a statement of the practices involved, in "forcing for market." In no department of horticulture do experience and judgment tell more than in forcing operations; but if "practice" be essential, it is certain that to get the best results, it must be directed by trained intelligence. In this country market-gardening under glass has greatly extended of late years, and many agriculturists, finding it no longer remunerative to grow wheat, have turned their attention to the growth of flowers or to market-gardening generally. As a rule these men have been successful because they have known how to adapt themselves to new conditions, and have not been mere slaves to routine. As competition increases it may be expected that market-gardening will become less remunerative, and hence the necessity for increased knowledge and quickened intelligence in order to meet the new circumstances. In the United States, in Germany, in France, in Belgium, in Denmark, this truth has been recognised, and horticultural schools and experiment stations have been established for years. In this country, as is usually the case in such matters, we have lagged behind, and have many arrears to clear off before we can deem ourselves on a level with the countries we have mentioned. And all this time we are importing, to an enormous amount, commodities a large proportion of which might be grown at home.

The experimental station in connection with the Cornell University has taken a very prominent position in teaching the principles of cultivation, and in furnishing the opportunity of putting them into practice. Its bulletins have consequently been read with interest. The present volume is, to a large extent, based on these bulletins, and will be valued accordingly. Within its prescribed limitations the reader will find an epitome of the most advanced views on the culture of plants. Much of the book is taken up with technical details, which need only be referred to here; but we may refer the reader especially to the paragraph on the use of the electric light for forcing-houses, at p. 80. It is very short, but contains a great deal of information which will be serviceable to those who are contemplating further experiment. The results obtained are substantially the same as observed on different plants by the late Sir William Siemens; but, if we remember rightly, the time required to mature the crops and ripen the fruit at Tonbridge Wells was much less than has been ascertained to be necessary in the United States. Probably the discrepancy is easily to be explained by differences of circumstances. "It will be found profitable," says Prof. Bailey, "to use the electric light for plant-growing, if at all, only in the three or four months of midwinter." A general summary of the contents and a good index render the volume easy to consult.

The Birds of Our Country. By H. E. Stewart, B.A. Pp. viii + 397. (London: Digby, Long, and Co., 1897.)

THE Natural History Societies of our public schools should add this book to their libraries. It contains brief illustrated descriptions of all the birds likely to be seen in the British Isles, and will afford young observers a means of obtaining interesting information on bird-life. We hope the book will not add to the number of indiscriminate collectors. The author refers to "many an enjoyable day spent rambling through the [New] Forest in search of something which might be deemed worthy of a place in our collections, and possibly of a paragraph in a natural history paper to be read at one of our social evenings afterwards." The "takes" of such rambles are also mentioned. It would have been well if a word or two of advice had been added on the folly of collecting specimens without studying them. The young collectors into whose hands the book will probably fall, should be told distinctly that their hobby must be exercised with discretion.

The Pamirs and the Source of the Oxus. By the Right Hon. George N. Curzon, M.P. Pp. 83. (London: The Royal Geographical Society.)

WE are glad that this notable contribution to geography has been reprinted from the *Geographical Journal*, and published as a volume handy in size and attractive in *format*. For ages the Pamirs and the Oxus have impressed the imagination of humanity, and though fancy has now to give way to facts, "the mystery and romance of the fabled Roof of the World having been extinguished by the theodolite and the compass, and superseded by the accurate delineation of scientific maps," this celebrated region is full of interest—how full can only be understood by those who read the present monograph, which happily combines historical records with personal experience.

The Journal of the Essex Technical Laboratories. Vol. ii. Edited by David Houston. Pp. 340. (Chelmsford: County Technical Laboratories, 1896.)

A HELPFUL *Bulletin* is published monthly by the Technical Instruction Committee of the Essex County Council. The bulletins issued from October 1895 to September 1896 are here brought together, and published in the form of a handy volume. Notes and articles on most branches of biological knowledge are included in the volume; and also a short course of lessons in elementary chemistry. Many of the articles are well illustrated, and they will all assist in making the agriculturist and horticulturist realise the value of scientific work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

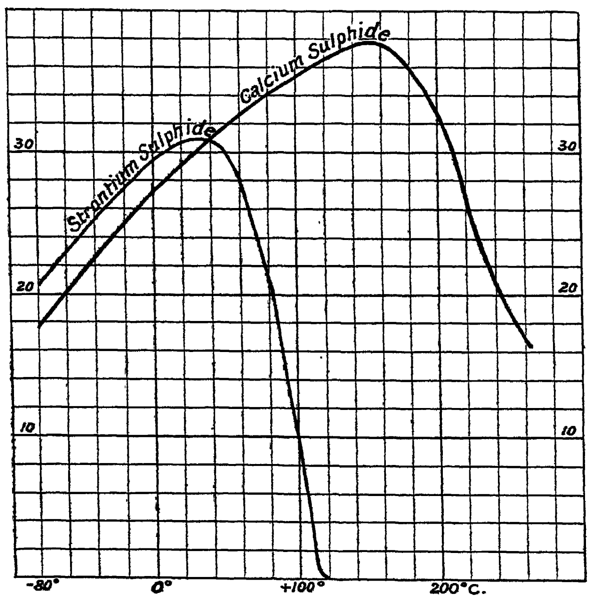
Effect of Change in Temperature on Phosphorescent Substances.

WHEN a substance that possesses phosphorescent properties is exposed to suitable light vibrations, it is found to glow with a certain brightness when the light is shut off.

When such substances are exposed under *similar conditions* for a sufficient length of time the intensity of the phosphorescent light emitted reaches a maximum, which maximum is constant for each substance.

If now the temperature of the substance under observation be altered, the other conditions remaining the same, it is found that the maximum intensity of the light emitted varies with the temperature, and that the maximum for any temperature is constant for that temperature.

The light to which the substances under observation were exposed was that from a spark discharge of a Leyden jar coupled up with the terminals of an induction coil. The instant the spark is stopped, the intensity of the light emitted by the substance is estimated by a photometer devised for the purpose. The principle of the photometer consists in diminishing light



that shines through an aperture of given area, by interposing thin sheets of oil paper. A slip of glass is also interposed, of the same colour as the light emitted by the phosphorescent substance. As yet this photometer has only been used to compare the maximum intensity of the light emitted from the same substance at different temperatures. Now let us suppose, for example, that with a specimen of calcium sulphide at $-40°$ C. ten papers had to be interposed before the light emitted from the sulphide and that from the photometer were of equal intensity; while at 96° C. only seven papers had to be interposed. By taking the reciprocal of the antilog of 10 and the reciprocal of the antilog of 7, we have a rough measure of the relative intensity of the light emitted at $-40°$ and $+96°$ respectively. The antilogs were plotted to scale, and from the curves thus obtained, the accompanying reciprocal curves, showing how the light emitted varies with the temperature, were plotted.

RALPH CUSACK.

Physical Laboratory, Trinity College, Dublin.

Sinistral Screws.

IF mechanical screws "bear" upon natural spirals, as of the *Gasteropoda* (NATURE, May 27, p. 79), it may be worth while to observe that sinistral forms survive in art, as in nature.

The silversmiths of Western India still commonly use a sinistral screw of very primitive form, a pin with a wire twisted round it, especially in the buckles of silver belts; things of very common wear. Europeans, coming into possession of such jewellery, are often sorely puzzled how to open and shut it. Yet these people are as right-handed as we; and write, as we do, "*with* the sun."

W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, S.W., May 28.

Luminous Phenomena observed on Mountains.

THE following account of an occurrence somewhat similar to those recently recorded in NATURE may be of interest. I will give it in the observer's (Rev. W. E. Postlethwaite) own words.

"On March 5, at 9 p.m., I was crossing the Towans, wind north-west; a slight shower came on, which lasted about ten minutes. During that time my hat-brim, ferrule of walking-stick, finger-tips, and the edges of a book I was carrying were phosphorescent, the same colour, and in some places as bright, as the light emitted by a glow-worm. The light was the brightest on the windward side."

The "Towans" referred to in the foregoing account are near Helston, Cornwall, on the sea coast, with an altitude ranging from sea-level to 174 feet above, and with a general downward inclination towards the north-west.

Trewirgie, Redruth, May 29. ARTHUR P. JENKIN.

The Designation of Wave-Clouds.

IN a general article on the "Photographic Observation of Clouds," published in NATURE of February 4 (vol. lv. p. 332), you call attention to the wave-clouds, the origin of which was first explained by Helmholtz, and remark that the name of "Wogen wolken" has been suggested as their designation. May I call your attention to a paper I read before the Linnean Society of New South Wales on August 29, 1894, in which the name *undulus* is suggested for the ripple- or wave-clouds. The name has the advantage of falling easily into line with Howard's nomenclature. And some name is necessary, for out of combinations of the elementary forms *stratus*, *cumulus*, *cirrus*, and *undulus* can be derived most of the diversified and ever-changing cloud-groups, which never cease to delight and astonish the eye and mind of man.

A. H. S. LUCAS.

Newington College, Sydney, April 16.

THE BAKERIAN LECTURE.—ON THE MECHANICAL EQUIVALENT OF HEAT.[1]

THE purpose of this research differs essentially from that of any previous research on the mechanical equivalent of heat. In order to diminish the loss of heat by radiation, as well as to obtain the equivalent for water in the neighbourhood of ordinary temperatures, the ranges of temperature over which the previous dynamical measurements have been made are greatly less than the standard interval between the physically fixed points of temperature to which all thermal measures are referred, and so have of necessity involved the use of scales, the intervals of which depend on the constancy of the relative expansions of such substances as glass, mercury, and air. On the other hand, in this research the object has been to determine the mechanical equivalent of the total heat necessary to raise the temperature of water over the standard interval of temperature, and thus to obtain directly the equivalent of the mean specific heat between the freezing and boiling points.

This undertaking is the result of the occurrence of circumstances which afforded an opportunity such as might not again occur. This consisted in the facilities offered by the appliances which formed the original equipment of the Whitworth Engineering Laboratory, in 1888, the more essential of these being an engine of 100 H.P., working one of Prof. Reynolds' hydraulic brakes. This brake maintains any constant moment of

[1] By Prof. Osborne Reynolds, F.R.S., and W. H. Moorby. Read before the Royal Society, May 20. [Abstract.]

resistance on the engine shaft, independent of the speed, all the work done being converted into heat, which appears in the rise of temperature of a steady stream of water flowing through the brake, the magnitude of which stream is independent of the load on the brake or the speed of the engine, and is under independent control.

The existence of the Manchester town's water, of a purity expressed by 3 grains of salts to the gallon, conveniently distributed in the laboratory, as well as auxiliary power, both steam and water.

Although unconsciously, the research was really commenced in 1890, when, without any intention of making a determination of the heat equivalent of the work done on the brake, but solely for the purpose of verifying the mechanical balance of the brake, provision for thermal measurements was added, and a system of trial instituted, in which the object sought was only that of obtaining consistent results over definite portions of the scales of uncorrected thermometers, eliminating the errors resulting from radiation by taking the differences of two trials. In these trials the temperature ranged from 40° to 50° F., and their development was continued over two years. Then it occurred to Prof. Reynolds that by the same method the great facility which this brake was then seen to afford would be available for the independent determination of the mechanical equivalent, if it could be arranged that water should enter the brake at the temperature of melting ice, and leave it at that of water boiling under the standard pressure. Since then all that would be required of the thermometers would be the identification of these temperatures, and with a range of 180° the error in scale over one or two degrees would be comparatively of small importance. At first the difficulties seemed formidable; but on trying by gradually diminishing the supply of water to the brake when it was absorbing 60 H.P., and finding that it ran steadily under control of its automatic gear till the temperature was within three or four degrees of boiling, he further considered the matter, and during the next two years convinced himself of the practicability of the necessary additional appliances by preliminary designs. These consisted of:—

(1) An artificial atmosphere or means of maintaining a steady air pressure of 4/3 atmosphere in the air passages of the brake.

(2) A circulating pump and water cooler, by which the entering water, some 30 lbs. a minute, could be forced through the cooler into the brake at a temperature of 32°, having been cooled by ice from the temperature of the town's main.

(3) A condenser by which the water leaving the brake at 212° might be cooled down to atmospheric temperature before being discharged into the atmosphere and weighed.

(4) Such alteration in the manner of supporting the brake on the shaft as would prevent excess of leakage from the bushes in consequence of the greater pressure of air in the brake, since not only would the leaks be increased, but when the rise of temperature was increased to 180° the quantity for any power would be diminished to one-sixth of that for a rise of 30°, so that any leakage would become six times the relative importance.

(5) Some means by which assurance of the elimination of the radiation and conduction could be obtained, as with a temperature of 140° F. above the laboratory these would probably amount to 2 or 3 per cent. of the total heat.

(6) Scales for greater facility and accuracy in weighing the water with a switch actuated by the counter.

(7) A pressure gauge or barometer by which the standard for the boiling-points might be readily determined at 3° or 4° F. above and below the boiling-point, so as to admit of ready and frequent correction of the thermometers used for identifying the temperature of the effluent water.

(8) Some means of determining the terminal differences of temperature and quantities of water in the brake, which would be relatively six times as large as with 30° rise.

These preliminary designs apparently demonstrated the practicability of the appliances, and also the possibility of their inclusion in the already much occupied space adjacent to the brake. But there remained still much to be done in the way of experimental investigation in order to obtain the data for proportioning the appliances.

In July 1894, Mr. Moorby having undertaken to devote himself to the research, the experiments necessary for the appliances were at once commenced, and these, together with the construction of the appliances and then standardising, and preliminary experiments while this was in progress, occupied till February 1896, when Mr. Moorby commenced the main experiments, which were continued into July 1896.

In these experiments the time of running was 62 minutes; the speed 300 revolutions a minute, on the speed gauges. Observations of speeds, of the temperature of the inflowing and effluent water, and of the temperature of the air were made every two minutes. Observations of the slope of the temperature of the shaft were made every eight minutes.

The temperature of the inflowing water varied from 32·5° to 34°, and that of the effluent from 210° to 214° F. The effluent water was cooled to 8·5° before entering the tank on the scales, in which it was weighed, weighings being taken before and after each trial.

The temperature of the metal surface of the brake being sensibly the same as that of the effluent water (212°), and by taking the difference in the work absorbed in two trials and the differences in the heats developed the errors of radiation and balance in the brake were approximately eliminated, and in order to complete the elimination the coefficient of radiation was approximately determined, so that a correction might be applied for any residual differences of temperature as observed, and in the same way with the slope of temperatures. Further assurance was also obtained by making some trials with the brake naked and others with it covered, so as to reduce the loss of heat to one-fifth; and, in the same way, with every circumstance which could effect the result trials, means were taken to vary the circumstances in different series of trials, so as to obtain an estimate of the limits of error. All the appliances were most carefully standardised; and taking all the limits of error into account the limit of the sum was less than 0·0003.

In all fifty-two trials were included in the final result. Of these—

25	with loads on the brake of	1200 ft.-lbs.	at	70 H.P.
21	,, ,,	600	,,	35 ,,
6	,, ,,	400	,,	23 ,,

From these, twenty-five separate determinations were made of the equivalent, subject to certain general corrections given below, which gave a mean value 777·91, and from this none of the separate determinations differed by as much as 0·2 per cent., which arranged in eight groups, according to the circumstances under which they were made, the greatest divergence from the mean was 0·05 per cent.

It was found impracticable to eliminate entirely from each determination the losses of heat due to radiation, conduction, leakage of water, &c., and so it was found advisable to determine what these losses were. This information was given by the trials themselves, and the necessary corrections were applied to each separate determination. As illustrating the extent to which the method adopted did eliminate these errors, it is interesting to remark that on the mean value of the equivalent determined, without taking these errors into account, the error was only 0·0192 per cent.

Certain final corrections, which had the same values for all trials, were made to the mean value of J, already given. These were introduced on the following various counts :—

I. Length of the brake lever (0·00042).
II. Salts dissolved in Manchester water (0·00003).
III. Air dissolved in water used in the trials (– 0·00021).
IV. Reduction of weighings to vacuo (– 0·00120).
V. Varying specific heat of water (– 0·00006).
VI. Pressure on thermometer bulbs (– 0·00037).
VII. Work done against gravity (0·00007).
VIII. Engagement of counter (0·00001).

Their total effect was to introduce a correction factor of (1 – 0·00125).

The mean corrected value of the specific heat of water between freezing and boiling points, as measured in mechanical units at Manchester, is found to be 776·94.

THE INTERNATIONAL GEOLOGICAL CONGRESS IN RUSSIA.

THE International Geological Congress may be said to come of age this year, for it was founded at Philadelphia in 1876, at a meeting held under the presidency of the veteran James Hall. The first organised session was held at Paris in 1878, and since then meetings have taken place at Bologna, Berlin, London, Washington, and Zürich. The seventh session is to be held at St. Petersburg, with Prof A. Karpinsky as President.

The ordinary meetings of the Congress will be held in the rooms of the Imperial Academy of Sciences at St. Petersburg. There will be a preliminary assembly of the members on August 28, the formal opening will take place on the following day, and the meeting will terminate on September 4. According to the Russian Calendar these dates will be twelve days earlier, namely, August 16, 17, and 23.

The meetings will extend over eight hours. From 9 till 10 a.m. the Committees of the Congress will deliberate ; from 10 till 2 p.m. there will be discussions on questions proposed in the programme of the Organising Committee. One hour is then set aside for visits to museums and to the exhibition of maps, sections, books, specimens and instruments—possibly some members may then take the opportunity of obtaining lunch. From 3 to 5 o'clock papers of a general character will be read, and these will be so arranged that only one branch of geological science will be discussed each day.

The Organising Committee will reopen the subject of the unification of geological nomenclature. The larger divisions of the earth's history must be based on general palæontological characters, and in defining the several systems attention will be specially given to the study of pelagic life and the evidences of organic evolution. In order that a system be well established it must be capable of subdivision into stages characterised by well-marked pelagic faunas, and these should have a European or equivalent value. It is recognised that sub-stages have only a regional value, while minor divisions have but a local character, and with these the Congress does not deal. The divisions, in short, which the assembly will be called upon to discuss are those of geological time, based on the occurrence of successive groups and zones of fossils ; the purely stratigraphical divisions are essentially regional or local, and they may reasonably be left for each country to fix according to its own necessities ; for they are all important in the interpretation of the structure of a district, in determining its economic resources, and in explaining the origin of its scenery. On the other hand, when we seek to trace out the history of the great changes which the earth at large has undergone, the more comprehensive life-divisions are all important ; and these only can be universally applied, and, we hope, universally adopted. It is true that life-divisions are no more to be rigidly defined than are stratigraphical divisions in the rocks, but fossils are the only guides for correlating the formations in countries far apart. There should be no serious disagreement among geologists, at any rate, with regard to the principles of correlation ; and there is no reason why, after full and friendly discussion, a particular nomenclature should not be generally accepted. It need not interfere with our local divisions, any more than great chronological terms, if applied to human history in general, would interfere with our own time-divisions marked by the reigns of successive monarchs.

The Organising Committee will also deal with the subject of petrographic nomenclature, in the hope of reducing the number of terms now used, and of preventing unnecessary names being introduced. In petrology, as in palæontology, one is nowadays in constant need of a dictionary or glossary, or table of synonyms, to understand the various names of rocks or rock-structures and fossils.

The scheme for Excursions in connection with the Congress is an elaborate one. There will be excursions both before and after the ordinary meeting, and those who have time and money will have grand opportunities of visiting many parts of the Russian empire in Europe.

Prior to the Congress there will be three excursions ; namely, to the Ural regions, to Esthonia, and to Finland. The Ural excursion is timed to take place between July 28 and August 27. There will be a general gathering of the party at Moscow on July 29, and those who join are advised to take thick boots, warm clothing, and waterproof cloaks, for there will be rough walking as well as long journeys in open carriages and on horseback. Messrs. Nikitin, Tschernyschew, Arzruni, Karpinsky, and Stuckenberg will act as leaders. The party will take train to Riazan, and thence journeying to Syzran, on the Volga, they will cross Jurassic, Cretaceous, and Tertiary strata. Thence from Samara to Oufa, Permian and Triassic rocks will be traversed, while onwards to the Ural mountains the party will pass over Carboniferous, Devonian, and Siluro-Cambrian strata, which present evidences of considerable metamorphism, and which, together with various schists, are penetrated by numerous eruptive rocks. The region is famed for its metalliferous deposits, and various mines in rocks bearing gold, copper, and manganese will be visited, as also will be the Imperial stone-cutting works at Ekatherinebourg. The return journey will be made by Perm, Kazan, and Nijni-Novgorod.

The excursion into Esthonia (August 13 to 27) under the direction of M. Schmidt, will be by rail to Reval on the Gulf of Finland, and then a visit will be paid to the Isle of Dago, when attention will be given to the fossiliferous Upper and Lower Silurian rocks.

The excursion to Finland will be made under the guidance of M. W. Ramsáy. The members will assemble at Helsingfors on August 21, and return to St. Petersburg on August 28. Tammerfors and Lavia will be reached, and attention will be directed to the glacial phenomena and the various crystalline rocks.

After the meeting of the Congress is over, the principal excursion will be to the Caucasus, leaving St. Petersburg on September 5, and arriving at Moscow on the following day. The excursion party will then be divided into three sections, A, B, and C. Section A will be conducted by Messrs. Nikitin, Gourow, Tschernyschew, Loutougin, Rouguéwitsch, and Konchin. Leaving Moscow, and travelling by Podolsk, the route will be over Jurassic, Carboniferous and Devonian rocks, and on to the Cretaceous strata of Koursk and Kharkow. Thence the

party will proceed to Rostow, at the head of the Sea of Azov, examining a mercury-mine and certain mineral springs, and ultimately reaching Wladikavkaz, on the northern side of the Caucasus mountains. Section B will start, under the guidance of Messrs. Pavlow and Amalitzky, from Moscow to Nijni-Novgorod, across Jurassic and Triassic formations to the Cretaceous rocks of Simbirsk on the Volga. Journeying southwards they will visit asphalt quarries, and by means of steamer and railway they will proceed along the plains of the Volga and the borders of the Kirghiz Steppes to Astrakhan and Wladikavkaz. Section C will be under the direction of M. Sokolow, and will journey to Kiew on the Dnieper, paying especial attention to the Tertiary and Post-Tertiary deposits. Following the river to Alexandrovsk, the party will ultimately join the two other sections at Wladikavkaz by way of Rostow.

Thus united the whole party will proceed across the mountainous country to Tiflis, under the direction of M. Loewinson-Lessing, some few members separating for a while to examine a glacier under the guidance of M. Kolenko. Tertiary, Cretaceous, Jurassic, and metamorphic rocks will be seen. From Tiflis all will proceed to Bakou, on the borders of the Caspian, and thence separating into two portions, they will traverse the mountainous region from east to west, and unite again at Rion. Some may spend a week in the Caucasus, examining the Mamisson glacier; others will have an opportunity of visiting Mount Ararat.

Those who desire to still further continue their field-studies among Cretaceous and Jurassic rocks, may take part in a general excursion into the Crimea. They will proceed by steamer from Batoum to Kertch, and eventually, on October 5, there will be a reunion of all the remaining excursionists at Sébastopol. Thus will terminate the great programme of expeditions planned by the geologists of Russia. H. B. W.

THE NEW LABORATORIES AT GUY'S HOSPITAL.

THE new laboratories which have been erected at Guy's Hospital at the expense of the staff of the medical school, and have entailed an expenditure of about 12,000*l*., were opened by the Prince of Wales on Wednesday in last week. The buildings occupy about one-third of the whole structure which is contemplated, and a further sum of 35,000*l*. will be required to complete the scheme. The entire building is designed to provide under one roof all the accommodation required by the school in all branches of the medical curriculum. The part of the building now opened contains a well-arranged lecture theatre capable of seating four hundred persons, and beneath it are three dark rooms. The first of these is designed for the reception of the spectrophotometer, polarimeter, and spectroscope, for the use of those engaged in work with them. The other two rooms are intended for galvanometric and photographic work. Other parts of the building are occupied by the laboratories and preparation room for physiological and pathological chemistry, a balance room, a calorimeter room, and a gas room. On the top floor the whole of the front of the building is devoted to the laboratory and preparation room for normal and morbid histology. Large classes can be accommodated, and the claims of investigation have received ample consideration.

An address of welcome was read to the Prince of Wales by Mr. Howse, the senior surgeon, and Dr. Pye-Smith, senior physician, described the objects of the new building in the following words :—

Your Royal Highnesses, my Lords, Ladies, and Gentlemen,—I have been asked by my colleagues, the lecturers, demonstrators, and tutors of this school of medicine to state very shortly the use and object of the building in which we stand.

While in every civilised country, except England and the United States, the training of physicians and surgeons is provided for by the Government as part of its duties, here the profession provides for itself and for the public. The schools of medicine in London have formed themselves around the great hospitals, and have only gradually acquired their present importance and repute.

Apart from practical instruction in the wards of the hospital, some knowledge of natural science has always been included in the preparation for this liberal profession. Physicians have always been botanists and chemists, surgeons have always been anatomists; nor need we look far for proofs that the highest attainments in scholarship and mathematics are admirable training for pathology.

During the last sixty years, great has been the development of these preliminary scientific studies, the indispensable foundation of rational, honourable and helpful medicine. We have now not only able lecturers on physics, on chemistry, and on biology, but well-equipped laboratories for each of these subjects, in which our students become practically familiar with scientific facts. We have twice rebuilt or greatly enlarged our museums and laboratories for *physiology*, for *clinical chemistry*, for *histology*, and for the new science of *bacteriology*. But, again, as our numbers increase and the progress of science goes on, we must pull down our barns and build greater. In medical science, as in a still more important discipline, the Augustinian saying is true, *Qui satis dixerit, perditus est.* We must go on, if we are not to fall back.

Accordingly, after repeatedly considering various plans for enlarging and remodelling the old museum and laboratories, we determined that none of them were satisfactory; and that we must erect a new building for the important department of physiology; one not comparable to the magnificent palaces which are called "Institutes" at Berlin and Strassburg, but such as may rank with the laboratories of our friendly rivals, St. Bartholomew's, St. Thomas's, and the other schools of London, of Cambridge, and of Edinburgh, fitted for the best possible teaching and the most advanced researches.

This part of the future range of museums and class-rooms is now completed. Immense labour has been bestowed upon it. Similar laboratories in this kingdom, and on the continent, have been visited and studied by our lecturers, and the result is what we have every reason to believe will be sufficient for another fifty years. Two names among many to whom we are deeply indebted demand particular mention—those of the architect, Mr. Woodd, and of Dr. Shaw, the Dean of the Medical School.

It is only right to explain how the necessary funds were raised.

We all know the grievous deficiency of rents which have compelled the Governors of Guy's Hospital to close some of their wards.

We know too, and shall never forget, how you, Sir, came to their help, and how, by your generous and practical aid, the prospects of further crippling of the charity were banished, and replaced by a hope that some day its closed wards might be reopened to the public.

The treasurer of the hospital could not give, and the medical school could never ask for, help from the hospital funds. Every pound given to Guy's Hospital is devoted to the direct relief of the patients. The school does not receive from, but gives to the hospital, with which its prosperity and almost its existence are united.

It is needless to say that the Government does not help medical science as it does on the continent, and our rich men are only beginning to learn to devote their wealth to founding colleges and laboratories and observatories, like those which do honour to our kinsmen across the Atlantic.

Only one resource remained open: we determined to appeal—to ourselves. We made a collection; all giving something as he was able, and with the money thus subscribed this physiological institute was built.

Here physiology will be zealously and efficiently taught, and fresh knowledge will be acquired. The old laboratories, where Sir Wm. Gull, Dr. Pavy, Mr. Golding Bird, and the late Dr. Wooldridge worked, will hand over a good tradition of industry, intelligence, and zeal to their successors, and the benefit will not be only for our students, but for the whole community.

Such institutes are too few; for they are not only "light-bringing, but fruit-bearing." They not only form the foundation of scientific and efficient treatment of disease, but are the source whence spring such discoveries as bless the whole world, and crown with the gratitude of nations the names of Jenner, of Simpson, of Pasteur, and of Lister.

One of our kings, sir, zealously helped forward Harvey's immortal work on the movements of the heart and of the blood; another founded the Royal Society, "to search out the secrets of nature by way of experiment."

To you, therefore, as a patron of all that tends to the increase of knowledge and the relief of suffering, we turn and ask your Royal Highness to open this laboratory.

In Harvey's words: *Ad viliorum animalium inspectionem cum Heraclito apud Aristotelem introire si vultis, accedite, nam neque hic Dii desunt immortales.*

The Prince of Wales then declared the building open, and, in the course of a short address, he is reported by the *Times* to have said:—I understand that the building which I have just declared open is to be used in great part for the study of those sciences which have for their object the observation of the natural laws of life. It was in such observations that your distinguished physician, Sir William Gull, first won renown. Nor is it possible to over-estimate the value of such work in the investigation and treatment of disease. One thing I would venture to impress upon our students—namely, that, in endeavouring to follow in the footsteps of the great and good men whom Guy's delights to honour, they should cultivate that gentle and humane spirit which, not confined to any one school, is the best possession of the medical faculty. I have made careful inquiries, and have every reason to believe that whenever experiments upon animals are performed in this school they are undertaken with the object of promoting advances in medicine and surgery which are likely to be of benefit to suffering humanity, and I have satisfied myself that such experiments are conducted under strict supervision, by highly qualified investigators, and that in practice the only operations performed upon animals which are not in a condition of complete anæsthesia are inoculations and hypodermic injections. Looking back upon the history of this school, one cannot but admire the wonderful powers of observation which enabled such men as Astley Cooper, Bright, Addison, Hodgkin, and Gull, with but slender aid from scientific apparatus, to add so largely to the sum of human knowledge. I need hardly remind you that more than one of these great workers in your profession has had his name perpetuated in connection with the discoveries he made in the wards of Guy's Hospital—discoveries which paved the way for the more enlightened treatment of some of the most frequent, and yet most fatal diseases to which man is subject. That harvest has been gathered, and for the present and future generations it remains, with more exact appliances and more delicate apparatus provided by the sister sciences, to seek on other fields to emulate their illustrious predecessors' example. To this end are needed ampler buildings, specially designed rooms, and complicated mechanical contrivances, all of them involving additional expenditure. Your senior physician has made it clear to all how, relying upon themselves, the staff of the medical school have erected this building. I may be permitted to emphasise the fact, to which Dr. Pye-Smith has alluded, that the present building is but an instalment of a more extensive design which is to be completed as soon as funds are forthcoming. I would venture to express a hope that this day may not be long delayed, and that when the building is completed, room will be provided to adequately display the unique collection of wax models which so much interested me when first I visited your museum. The medical staff have expended as much as they safely can, and it is to men of wealth and philanthropic aspirations that we confidently look for further assistance. Let such men once realise that money given for the purposes of medical education directly benefits humanity, and I cannot doubt that that spirit, which has prompted the British people to provide by voluntary effort what in other countries is provided by the State, will prove effective in the present need. On you students of medicine—and a medical man, as Dr. Wilks has said, should be a student till he dies—it devolves so to order your life's work that you make the best use of the improved opportunities thus provided, and to take care that the great profession to which you have aspired to belong shall, when you leave it, stand as high in the service and in the affection of the public as it does at the present time.

NOTES.

THE Select Committee of the House of Commons appointed to inquire into the administration of the museums of the Science and Art Department has presented an interim report calling attention to the peril of destruction by fire to which the collections at the South Kensington Museum are exposed. After describing the general character of the buildings and their inflammable structure, the Committee conclude their report with the following observation:—"This necessity of providing buildings suitable for the exhibition of the objects of art and science collected at South Kensington has been long under the consideration of successive Governments. Your Committee regard it as their immediate duty to lay before the House of Commons by means of an interim report their very strong opinion that permanent buildings for the adequate accommodation of the collections at the South Kensington Museum should be proceeded with without delay. They are of opinion that it will be a source of grave discredit to the country if the settlement of this matter, which has been the subject of consideration by Government for many years, and of endless correspondence between the departments concerned, is any longer delayed."

THE Paris correspondent of the *Times* reports that at Monday's sitting of the Academy of Sciences, M. Moissan communicated the results of his experiments with Prof. Dewar on the liquefaction of fluorine gas. M. Moissan announced that the gas had been liquefied at about 185° C. below zero. When a current of fluorine gas is passed into an apparatus maintained in the midst of liquid oxygen in tranquil ebullition at a temperature of −180° C., liquefaction does not occur. But as soon as that temperature is diminished by exhausting the gas above the liquid oxygen, the liquefaction of the fluorine begins, and a clear yellow and extremely mobile liquid is obtained, which resumes the gaseous state as soon as the temperature rises. This liquid has lost the chemical activity characteristic of fluorine in a state of gas. It no longer attacks glass, silicon, sulphur, or phosphorus. Fluorine at a very low temperature, however, still attacks carburetted hydrogen, and its affinity for hydrogen seems still to exist.

JUST too late for insertion in last week's NATURE we received a cablegram from Prof. A. B. Macallum, Local Secretary for the forthcoming meeting of the British Association at Toronto, asking us to urge members of the Association to apply for Canadian Steamship berths as soon as possible, as the berths still remaining will soon be filled.

SIR ARCHIBALD GEIKIE had a hearty reception from geologists in America during his recent visit. The number of *Science* which has just reached us contains a long article, by Prof. J. F. Kemp, upon the visit of the distinguished director of our geological survey, and it is evident from the account that geologists in America regarded the occasion as one of exceptional interest. Sir Archibald Geikie crossed the Atlantic to open a new course of lectures on geology, founded in connection with the Johns Hopkins University, Baltimore, by Mrs. G. H. Williams. The purpose of the foundation is to support an annual course of lectures in geology, to be given alternately by European and American geologists of distinction; and the fact that Sir Archibald Geikie was chosen to deliver the first course is a high compliment to his learning, as well as a testimony to the breadth of his sympathies. Before he arrived in America, invitations were sent by the Johns Hopkins University to geologists throughout the country, asking them to be present, and to take part in the excursions which had been arranged. In response, fifty or more leading geologists in America accepted. While the lectures were being delivered, short excursions were conducted almost daily to places of

geological interest near Baltimore, on one of which Sir Archibald Geikie and his companions were the guests of the Secretary of the Navy at the Naval Academy, Annapolis, and upon one of the United States Government vessels on a trip to view the Cretaceous and Tertiary formations along the Severn River. A longer excursion was made at the close of the lectures, so as to illustrate the geology of the State of Maryland. Through the efforts of Prof. W. B. Clark, who is also State Geologist of Maryland, the interest of the Governor of the State and of the principal railway and mining officials had been secured, so that free transportation was given on the Baltimore and Ohio, the Cumberland and Potomac, and the Western Maryland Railways, as well as on one of the State official steamboats. Before breaking up, the entire company of geologists signed and presented a short address of thanks to the Board of Commissioners of the Maryland Geological Survey and the State Geologist, for the hospitable forethought which had enabled them to spend four days in inspecting a region presenting so many interesting geological aspects. At the close of the Baltimore visit Sir Archibald Geikie went to Washington, where he delivered an address before the Geological Society, and was afterwards given a reception in the rooms of the U.S. Geological Survey. He also gave addresses to the students of Bryn Mawr College, the Philosophical Society in Philadelphia, and the Brooklyn Institute. The different institutions seemed to vie with one another in doing honour to their guest; and it is to be hoped that when an opportunity arises, the cordial feeling thus manifested will be fully reciprocated. Sir Archibald Geikie returned to London a few days ago. His lectures at the John Hopkins University will ultimately be published.

WE regret to hear that Dr. Fritz Müller, the well-known biologist, died at Blumenau on May 21.

A BILL to legalise the use of weights and measures of the metric system was given a first reading in the House of Commons on Thursday last.

AN afternoon meeting of the Anthropological Institute will be held on June 15, at the South Kensington Museum, when Mr. A. P. Maudslay will lecture on "The Maya Monuments and Inscriptions in Central America."

IT is announced that the memorial to Joseph Thomson, the African explorer, will be unveiled by Sir Clements Markham, K.C.B., F.R.S., at Thomson's native town, Thornhill, near Dumfries, on Tuesday next, June 8.

THE great lens for the Yerkes telescope has just been finished by the Clarks, at Cambridgeport, and shipped to the University of Chicago, where it will be immediately mounted, as the tube and connected apparatus are already in position.

IN reply to a question asked in the House of Commons on Friday last, whether any steps had been taken to fix the site of the new magnetic observatory at Greenwich, the First Commissioner of Works replied that a site had been selected, with the concurrence of the Astronomer Royal.

A NEW biological station at Millport, on the Clyde, was opened a few days ago (says the *British Medical Journal*) by Dr. John Murray, F.R.S. The station has been erected at a cost of 1500*l.*, and though in regard to accommodation and equipment it cannot compare with many similar institutions in this country and the continent, as Dr. Murray pointed out, its position makes it a place of very great possibilities. The collection of the late Dr. Robertson, who did so much for the station, has been presented by his wife for the museum of the building.

THE State recognition given to the International Congress of Medicine and Surgery, to be held in Moscow in August next, is referred to in the *Lancet*. The Czar has taken the Congress under his patronage, and has consented to receive deputations from the various nationalities represented at the Congress. It is probable that the reception will take place in St. Petersburg immediately after the close of the meetings in Moscow. The Russian Government has acted most liberally towards the Congress. It has increased its original grant of 50,000 roubles towards the expenses by an additional grant of 25,000. This makes the handsome total of 75,000 roubles, or about 8000*l.* at the present exchange. In addition to this, the State has promised free railway tickets to members of the Congress from the frontier to Moscow and back. To Russian members similar free tickets will be granted from any part of the empire. Just as liberal recognition has been given by the Russian Government to the International Geological Congress to be held at St. Petersburg at the end of August.

IN connection with the recent correspondence in these columns on luminous phenomena observed on mountains, it is interesting to direct attention to a very remarkable series of observations of electrical storms on Pike's Peak, Colorado, contained in vol. xxii. of the Annals of the Astronomical Observatory of Harvard College, and described in NATURE (vol. xliii. p. 595, October 16, 1890). Luminous jets appeared very often along the telegraph wires for the length of an eighth of a mile, and the anemometer cups looked like revolving balls of fire. Upon touching the anemometer under these conditions, an observer found "his hands instantly become aflame. On raising them and spreading his fingers, each of them became tipped with one or more cones of light nearly three inches in length." Many more striking effects of this character are described in detail in the report to which reference has been made.

THE Smithsonian Institution is publishing in their "Miscellaneous Collections" a number of interesting memoirs submitted in the Hodgkins Fund Prize Competition. No. 1077 of this series is a contribution by Mr. A. McAdie, on the equipment and work of an aero-physical observatory, in which he deals especially with the question of future research in connection with our knowledge of atmospheric air and the prevision of weather. After the experience of twenty-five years, the author asks, "Has the synoptic map realised the expectations of meteorologists, and justified the expense of its existence?" The answer is in the affirmative; but if the further question is asked whether the forecaster of to-day is far in advance of the forecaster of 1870, the reply is uncertain, and the experience of recent years would seem to indicate that we have nearly exhausted the capabilities of the weather map in its present form. An aero-physical laboratory would afford opportunity for important research and investigation, and the author draws attention to some profitable lines of study bearing upon the conditions which control the weather. Among such investigations, Oberbeck's papers on the "Motions of the Atmosphere," and von Bezold's "Thermodynamics of the Atmosphere" may be mentioned as examples of the lines indicated. The study of atmospheric electricity also offers possibilities of great extension of our knowledge of atmospheric phenomena. In 1752 a simple experiment demonstrated the nature of the lightning flash, but at the present time the origin of the electricity of thunder-clouds, and similar questions, are as the nature of the lightning was before the time of that experiment. Much useful scientific work in weather forecasting has undoubtedly been done, but it remains none the less true that the present condition of our knowledge is still unsatisfactory.

IN the House of Lords on Friday last, Lord Stanhope moved —"That her Majesty's Government should be invited to take such further steps as are necessary under the Finance Act, 1894–96, to preserve in the country 'such pictures, prints, books, manuscripts, works of art, and scientific collections, not yielding income, as are of national, scientific, or historic interest.'" Speaking upon the subject of the motion, Lord Kelvin pointed out its great importance so far as scientific collections were concerned. It might have an exceedingly injurious effect upon scientific investigation in this country if the heavy death duties were charged upon apparatus for scientific research or upon natural history collections, the property of private owners. Very large sums of money had been spent on private observatories. A large part of the astronomical investigation in the United Kingdom had been performed by amateur astronomers, if he might use the word, who stood at the very head of scientific men in respect of knowledge and skill in scientific investigation. A large amount of money had been spent upon private observatories, on great telescopes, and on other instruments of research, which would be subject to exceedingly heavy death duties, and the heirs of the proprietors might find it impossible to keep them. The result might be that it would be necessary to sell them; foreign purchasers might get them, and those valuable tools for scientific work might be sent out of England and leave this country so much the poorer in respect of scientific work. The same might also be said of natural history collections. Such collections were of unique value. A man might spend his whole life in the work of making such collections and leave something that was of priceless value in reality, and which would be estimated at a very high money figure if the expense involved in creating the collection was to be taken into account. It would be most disastrous that such natural history collections or apparatus for scientific investigation should be subjected to the severe death duties that were charged on those to whom was left property which they could use, and which might be sources of income and revenue to the inheritors, when that which was inherited could only be of use through the inheritor devoting himself, as the creator of the collection had devoted himself, to the public good and for the advancement of science. He thought it would be exceedingly bad, and in every way undesirable that a duty anything more than merely nominal should be charged in such cases.—Lord Cross explained that there was a great desire on the part of the Chancellor of the Exchequer to deal fairly with this matter. Anything that could be done within the terms of the Act of Parliament would be done by him to keep works of art, whether they be pictures, manuscripts, scientific collections, or scientific instruments, in the country. He hoped, therefore, that the motion, with the main object of which the Government fully sympathised, would not be pressed. The motion was afterwards negatived without a division; so the decision whether the objects referred to shall be liable for estate duty or not, remains with the Chancellor of the Exchequer.

A VERY valuable address on the progress of medicine in the Victorian Era, delivered on May 27 by Mrs. Garrett Anderson, M.D., before the East Anglian Branch of the British Medical Association (of which branch she has been elected President), concluded with the following clear statement of the directions in which advances may be gained by research. "It is in medicine proper that more light is specially needed. We want, in medicine, more of the knowledge that can only be gained through research. We want to know the real nature of malignant growths, the complete life-history of the bacillus of diphtheria, of the parasite of malaria, the conditions they require, and how to produce immunity from them and from tuberculosis. It does not need much imagination to realise how the world would be helped, and its sorrows lightened, if cancer, consumption, and diphtheria could be brought under control in at all the same measure as small-pox, thanks to Jenner, has been brought; nor how civilisation would advance by leaps and bounds in many parts of the world if malaria could be effectually combated. Victory in these directions can only come through patient and laborious research, and we should all do our best so to educate public opinion that the true value of this work should be generally recognised, and that the demand for it should no longer be restricted within the narrow limit of the world of science."

PROF. KOCH's final reports upon his rinderpest investigations at Kimberley, appear in the Cape Town *Agricultural Journal* of April 1. The following extracts from the last report, dated March 22, are of interest:—"I consider my researches, respecting the rinderpest, finished in the main, and I believe that I can leave the further working out of them to Dr. Turner, who will for some time still have the assistance of Dr. Kohlstock, and later that of Dr. Kolle, should it be possible to arrange this. This ensures the continuity between my work hitherto and the further investigations at the experimental station. What I had been able so far to find out regarding the microbe of the rinderpest seemed to me too uncertain to mention in my reports. But I have shown Dr. Turner everything I have found in this respect, and he will try to gain further facts about the occurrence and habits of these microbes which, at any rate, do not belong to the class of Bacteria. The discovery that by injection of gall taken from rinderpest animals, sound animals may be protected against rinderpest, and that this discovery is also practically applicable, I consider absolutely proved in view of the results achieved on the farm 'Susanna.' Should my hopes respecting the artificial production of rinderpest-gall by mixture of gall and rinderpest-blood, about which I am not quite certain at present, not realise themselves, it will still be possible to obtain any desired quantity of effective gall by infecting a proportional number of cattle with rinderpest blood and killing them on the sixth or seventh day of the illness. The use of gall for immunisation seems at present to me to be so far superior to immunising with serum, that I would advise the latter procedure to be applied only experimentally."

PROF. J. A. HARPER's paper "On Nuclear Division and Free Cell-formation in the Ascus," reprinted from Pringsheim's *Jahrbücher*, completes a valuable series of observations on the obscure process of nuclear fusion which takes place immediately before the formation of the spores in many of the Ascomycetes. The author does not take the view of several French observers, that this fusion of nuclei is of a sexual character.

THE *Bulletin of Miscellaneous Information*, issued by the Superintendent of the Botanic Garden, Trinidad, mentions the very interesting circumstance that in that island a species of *Bauhinia* (*B. magalandra*, n. sp.), belonging to the Leguminosæ, is pollinated by the agency of bats, the first instance recorded of a "mammalophilous" flower. On visiting a flower the bat alights upon and holds fast to the protruded stamens, and attacks the erect and curved petals. The object of the visit of the bats appears to be not any nectar secreted by the flower, but the insects which are attracted to it by its odour. The flowers open only in the evening.

TOWARDS the end of the notice of vol. ii. of the Cambridge Natural History, in our issue of April 29 (vol. lv. p. 610), reference was made to the admirable illustrations, and regret was expressed that the name of the artist did not appear to be given. We are glad to be able to say that the artist was Mr. Edwin Wilson, of Cambridge, whose illustrative work has taken a high place in science for some years. The volume lately reviewed was written by several different contributors, and, as

there was no preface, the editors were unable to say how very much it owed to Mr. Wilson's skill and care.

To the list of cave animals which appears in Dr. A. S. Packard's monograph in the "Cave Fauna of North America" must now be added seven forms which are new to science, and several forms which, while known, have not hitherto been definitely reported from Mammoth Cave, Kentucky. This new material is described by Dr. Ellsworth Call in the *American Naturalist* (May). The specimens described are very minute, and this fact is in itself sufficient to explain their late appearance in lists of the cave fauna. The paper is a noteworthy contribution to a knowledge of the life of the most interesting cave on the American Continent.

A REPRINT from the *Transactions* of the New York Academy of Sciences gives an account of the results obtained by an expedition to Puget Sound, organised by the Department of Zoology of Columbia University in the summer of 1895. The party consisted of six members, under the leadership of Dr. Bashford Dean. Their main object was to obtain materials for the study of the development of the Chimeroid fish *Hydrolagus*, and eggs and young of the Myxinoid form *Bdellostoma*, both known to be abundant there. In both these respects success was achieved, and large collections of other groups of marine animals were secured for future study.

AMONG noteworthy articles which have come under our notice during the past few days are the following:—Dr. R. W. Shulfeldt points out, in the *Photogram* (June), that many of the figures throughout zoological literature are very frequently anything but correct, depicting often the subject in impossible attitudes, badly proportioned, and with erroneous portrayal of characters. To assist in the improvement of this state of things, he describes how photography should be called in with the view to secure pictures of living animals for reproduction by photographic processes.—The *Century Magazine* for May contains three well-illustrated articles on the construction and use of kites for meteorological and photograph purposes. In the June number of the same magazine, Mabel L. Todd describes the establishment and work of the Harvard College Observatory.—An address on "The Problems of Astronomy," delivered by Prof. Simon Newcomb at the dedication of the Flower Observatory, University of Pennsylvania, is printed in *Science* of May 21.

SOME further details, of great interest as to the fermentation of sugar in the absence of yeast-cells (see NATURE, March 11, p. 442), are given in the current number of the *Berichte* by Buchner. The active extract of yeast very rapidly loses its power of producing fermentation, owing probably to the presence of peptic enzymes. The activity of the solution is not affected by the presence of antiseptic substances, and the solid residue left on evaporation at a low temperature is found to yield an active solution, even after having been kept for nearly three weeks. These facts seem to definitely prove that the fermentation in these cases is not brought about by living protoplasm in any form, but is really due to the substance which the author has termed zymase. This is further confirmed by the fact that dried yeast which has been heated at 100° for six hours, and is incapable of further development, still yields an active solution when treated with sterilised 37 per cent. sugar solution.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (young) (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by the Hon. Sir W. Grantham; a West African Sheep (*Ovis aries*, var. ♂) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; a Broad-snouted Cayman (*Caiman latirostris*) from South America, presented by Mr. C. L. Hutchings; an Olive-brown Snake (*Phrynonax fasciatus*) from Trinidad, presented by Mr. R. R. Mole; a Pleasant Antelope (*Tragelaphus gratus*, ♂), four Royal Pythons (*Python regius*) from West Africa, thirteen Cunningham's Skinks (*Egernia cunninghami*), two Punctulated Tree Snakes (*Dendrophis punctulatus*) from Australia, deposited; an Alpaca (*Lama pacos*, ♂) from Peru; two Red-topped Amazons (*Chrysotis rhodocorytha*), three White-eared Conures (*Pyrrhura leucotis*) from Brazil, purchased; two Japanese Deer (*Cervus sika*, ♂ ♂), a Red Deer (*Cervus elaphus*, ♀), a Burrhel Sheep (*Ovis burrhel*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE ROTATION PERIOD OF JUPITER'S SATELLITE III.—Mr. Douglass has quite recently determined the period of rotation of Ganymede, Jupiter's third satellite, the period being given as 7 days, 5 hours (Kiel Telegram). This satellite is the brightest and largest of them all, and its sidereal revolution is 7 d. 3 h. 43 m., so that the period of rotation is practically the same as the time of its orbital revolution. This observation partly corroborates what Herschel concluded in 1797, namely, that, like our moon, all the satellites of Jupiter turn the same face towards their primary, thus always presenting to us, when in the same relative situations, the same obscure or brilliant sections of their globes. Engelmann's researches in 1871, and C. E. Burton's, two years later, made this statement of Herschel's almost certain regarding the outer satellite, and since that time it has always seemed probable that it would also apply to the other three. This new observation of Mr. Douglass shows that the deductions of the earlier observers were not very far from the truth.

Referring to this satellite in 1893, Prof. W. H. Pickering (*Astronomy and Astrophysics*, vol. xii. p. 199) said: "On account of its size and brightness, this is much the easiest satellite to observe. Indeed, even the occasionally elliptical shape of its disc has been noted by Lassell, Secchi and Burton. . . . Like our moon, therefore, its period of rotation coincides, at least approximately, with that of its revolution in its orbit. . . . Its surface markings are readily seen, especially during transit, the most conspicuous being a dark belt situated in the northern hemisphere, and inclined about fifteen degrees to its orbit."

AUTOMATIC PHOTOGRAPHY OF THE CORONA.—The idea of connecting several different kinds of instruments with some sort of central automatic arrangement by which one man may work them all during a total eclipse of the sun, is not new; but weather conditions have up to the present prevented any trial being made at the time of an actual eclipse. Mr. David P. Todd, who for the past few years has given considerable attention to this question, describes in the current number of the *Astrophysical Journal* (No. 5, vol. v.) the special automatic shutter and electric commutator which was devised for the Amherst Eclipse Expedition of last year, but which was, unfortunately, not used owing to the bad weather. In all twenty photographic instruments would have been worked by an automatic system, which would have given more than four hundred exposures with several types of reflecting and refracting telescopes, photographic doublets, a pair of spectroscopes, photometers, and a pair of polariscopes.

The system which Mr. Todd advocates is an electric system of control, and he has found that it is perfectly competent to operate any available number of eclipse instruments adapted for photographic purposes; it further makes the time record of every automatic movement in a form which can be identified.

It would be difficult to give the reader a clear idea of this arrangement without the medium of an illustration; so that we refer him to Mr. Todd's article for detailed information.

THE GEGENSCHEIN OR ZODIACAL COUNTERGLOW.—In some former numbers of the *Astronomical Journal* (*A. J.*, vii. 186, xi. 19, and xiii. 169), Prof. Barnard contributed his observations of this phenomenon as seen at the Lick Observatory. His communication to a more recent number (No. 403) of the same journal contains some further observations of considerable interest made at the Yerkes Observatory. He

points out that although these naked-eye observations are subject to a more considerable personal error than if they could have been made with any kind of instrument, yet the determination of the position of this phenomenon depends to a great deal on the experience of the observer. The best method he suggests for its location is to estimate the distance of its centre from the nearest fixed star, and then to identify the star by a chart or an equatorial pointing; by this means he can ordinarily determine the centre to within one degree. Any attempt, he says, to locate its position by tracing the outlines among the stars can only lead the observer to very crude results. Prof. Barnard's observations have indicated that the Gegenschein seems subject to periodical changes in the first parts of October and April; but the weather this year did not permit of a corroboration of this statement. The present observations show that this phenomenon has a north latitude as formerly, and that there is still a tendency to lag in longitude; that is, its longitude is not exactly 180° greater than that of the sun. The following summary shows the results for the last fourteen years:—

Dates.	Lat.	Diff. Long. (λ - ☉)	No. Obs.
	°	°	
1883-1887	+0·4	179·4	16
1888-1891	+1·3	179·4	16
1893	+0·5	179·6	22
1894-1897	+0·4	179·9	11

It may be stated that the difference in longitude for the last four years given above is rather high, owing to the fact that the three observations of 1894 made the difference greater than 180°. Those for 1895 and 1897 gave a value considerably less than 180°.

PERIODIC VARIATIONS OF RAINFALL IN INDIA.

THE meteorology of India during the past five years, 1892-96, has been characterised by the largest and most marked periodic variation of rainfall during the past fifty years at least, and probably for a much longer period. The late Mr. Blanford's monograph on the rainfall of India (page 15) gives a brief statement of the method he adopted for ascertaining the average rainfall of India, year by year, and the normal average. According to this method the mean normal annual rainfall of India is, very approximately, 41 inches. The following gives a comparison of the actual mean rainfall of India with the normal mean for each year from 1875 to 1896, determined by Mr. Blanford's method.

Year.	Mean actual Rainfall.	Variation from normal.	Percentage variation.
	Inches.	Inches.	
1875	43·47	+ 2·38	+ 6
1876	36·60	- 4·49	- 11
1877	36·81	- 4·28	- 10
1878	47·43	+ 6·34	+ 15
1879	42·78	+ 1·69	+ 4
1880	39·53	- 1·56	- 4
1881	41·19	+ 0·10	0
1882	43·73	+ 2·64	+ 6
1883	40·97	- 0·12	0
1884	42·82	+ 1·73	+ 4
1885	42·14	+ 1·05	+ 3
1886	44·11	+ 3·02	+ 7
1887	43·51	+ 2·42	+ 6
1888	39·55	- 1·54	- 4
1889	43·50	+ 2·41	+ 6
1890	41·77	+ 0·68	+ 2
1891	37·55	- 3·54	- 9
1892	46·18	+ 5·09	+ 12
1893	50·16	+ 9·07	+ 22
1894	47·56	+ 6·47	+ 16
1895	38·90	- 2·90	- 7
1896	36·26	- 4·83	- 12

The preceding data indicate that from 1876 to 1891 the annual rainfall of India varied somewhat irregularly and by less than 10 per cent. from the normal with one exception, viz. during the period 1876-78. The meteorological features of this period were very remarkable (*vide* NATURE, vol. xxi., page 477, "On the barometric see-saw between Russia and India in the sun-spot cycle," by H. F. Blanford), the most noteworthy being the drought and famine in Madras in 1876, and the scanty rainfall in North-western India in 1877, which gave rise to considerable suffering. Mr. Blanford subsequently traced the cause of the deficient rainfall in North-western India in 1877 to conditions and actions resulting from excessive snowfall in the Himalayan region during the winter of 1876-77.

The causes of the drought in Mysore and the Madras and Bombay Deccan in 1876, have as yet not been fully ascertained. The snowfall of the winter of 1875-6 was unusually scanty in the North-western Himalayas, although there was a heavy local fall in March and April in a part of the Kashmir Himalayas. The Madras drought and famine was probably due to more general actions and conditions than the winter Himalayan snowfall.

The present meteorological period of abnormal conditions and rainfall it will, however, be seen is not only more prolonged, but is accompanied by much larger variations in the amount and distribution of the rainfall than were experienced in the period of 1876-78. It is, moreover, noteworthy that the cycle or period commenced with excessive rain, continued for a period of three years, and culminating in the year 1893 in an average excess of 9·07 inches, or 22 per cent. of the normal fall. This excess rainfall in India in 1893 was equal to the amount of water necessary to supply its largest canal, the Ganges canal, 300 feet wide, 10 feet deep, for a hundred years. This comparison gives a feeble estimate of the surplus water precipitated over India in 1893, in consequence of the special meteorological conditions and actions of the period.

In order to understand the causes of the partial failure of the crops over at least two-thirds of India in the year 1896, it is necessary to bear in mind the more prominent features of its meteorology, that differ very largely from the meteorological conditions in European countries. The following is a brief statement of the chief features of the two monsoon periods in India.

The year in India may be broadly divided into two seasons or monsoons—viz. the north-east monsoon and the south-west monsoon. These names are derived from the direction of the winds prevailing in the Arabian Sea and Bay of Bengal during the two periods. They are inapplicable over the greater part of India, where the winds are from directions nearly opposite to those indicated by the names of the seasons, and are chiefly determined by the axial directions of the local river valleys. Thus the winds in South Bengal are from south-east, and in Bihar from east, during the south-west monsoon, and are from the opposite directions in the north-east monsoon. It would hence be more appropriate to call the two seasons in India the dry monsoon, and the wet monsoon from their most characteristic features.

The dry monsoon or season usually commences in November or December, and continues until May. Winds of land origin prevail more or less steadily in the interior, and hence the period is usually marked by great dryness of the air and little or no rain. The first three months of this period (December to February), characterised by a comparatively low temperature, are known as the cool weather season; and the second three months (March to May), when the temperature increases rapidly, and culminates in a period of excessive heat in May, as the hot weather season. During the cold weather season, shallow depressions of large extent, the majority of which form in Persia, enter India from Baluchistan and traverse Northern India from west to east, distributing light rain in the Indo-Gangetic plains and heavy snow over the Western Himalayas. The severity of the hot weather season is occasionally relieved by the occurrence of series of thunderstorms and duststorms, which cool the air for brief periods. Over nearly the whole of the interior of India the cold weather and hot weather disturbances occupy a very small portion of the period, and the characteristic features of the dry season are persistent dry weather, with clear skies and large diurnal range of temperature.

The chief crops in Northern and Central India during this period are wheat, barley, linseed, &c., and irrigation either from canals, tanks, or wells is essential in almost all districts for their successful cultivation. If the summer rains cease much earlier than usual, it is not possible to plough and sow the higher

and drier lands, and the area of cultivation in the dry season under these conditions is hence largely diminished. If the winter rains are light and scanty, the crops are more or less severely affected on all the higher lands where irrigation from wells, &c., is necessarily limited.

The rains of the wet season set in suddenly on the west coast of India in the first week of June, and a little later (in the second or third week of June) on the Bengal coast, and extend more or less rapidly into the interior. The prevailing winds of this period are of oceanic origin, and are, in fact, the northward extension of the winds of the south-east trades.

The extension of these winds northwards across the Equator and up the Indian Seas usually beg ns in the third week of May, and gives a complete and permanent change of weather (lasting for five or six months), more especially over the land area of India. The winds due to the extension of these massive humid air currents usually begin to give daily rain to the Malabar coast in the last week of May, and to the Bombay coast on June 4 or 5. The humid currents advance more slowly into the interior, but are usually established before the end of the month over the whole of India. Cloudy, showery, or rainy weather, with a moderately high temperature and small diurnal range of temperature, prevail during the next three months, which are in a striking contrast to the excessively hot and dry weather that has prevailed during the previous two or three months.

The rainfall of India during this period is of the greatest importance, and is sufficient without the aid of irrigation for the crops, except in a few districts (notably Sind and the West Punjab). The rainfall varies considerably in distribution, and slightly in average amount from year to year. The general volume of the current—and hence of the average seasonal rainfall in India—appears to be primarily dependent upon the strength of the currents in the sea areas to the south of India, and hence also of the south-east trades. Consequently it might be expected that any large and persistent variations in the strength of the south-east trades would be reproduced in the strength of the south-west monsoon currents and in the rainfall of the season in India. The local strength of the current in different parts of India varies, to some extent, from year to year, and it has been found that the distribution of the rainfall is largely dependent upon the pressure and other abnormal conditions prevailing in India at the time of its extension, and hence that these can be utilised to forecast the general character of the distribution of the monsoon rainfall. It has been shown, chiefly by Mr. Blanford, that the amount and distribution of the winter snowfall in the Western Himalayas is an important factor in determining these conditions, and hence in modifying the local distribution of the rainfall during the wet or south-west monsoon. Excessive snowfall during the winter proper (*i.e.* December to March), or heavy and unusual snow in April or May, affect the pressure distribution in such a way as to deflect the monsoon currents in their entry into India from one portion of the area (usually North-western India), and determine it more largely than usual to another portion (as, for example, Burma, Bengal or the Peninsula). Under such conditions, one part of the Indian monsoon area receives unusually scanty rain (leading, perhaps, to drought and famine), whilst another area obtains excessive rain. The last notable example of this was in 1891, when Rajputana suffered severely from drought. The winter of 1890–91, in the Western Himalayas, was very severe, and the snowfall excessive and prolonged until May.

It is of the greatest importance to distinguish between the general conditions in the oceanic area (more especially the strength of the south-east trades) affecting the general strength of the monsoon currents prevailing in the Indian monsoon region and the local conditions determining its relative strength in different portions of the Indian land area. For many years —viz. from 1879 to 1891—the local conditions were undoubtedly the predominant factor determining the variation of the south-west monsoon rainfall in India; but the year 1892 introduced conditions and actions, leading to a very large cyclical variation of rainfall, which cannot be explained by local conditions in India, but which appear to be, in part at least, due to variations in the general strength of the south-west monsoon circulation as depending upon corresponding variations in the south-east trades.

The crops during the south-west or wet monsoon may be locally deficient, either from excessive rain and floods or from scanty rains. Partial failure of the crops from excessive rain is usually local in its extension; but the excessive rainfall of the years 1893–94 undoubtedly affected the crops to a serious extent in many parts of the Central Provinces, Central India, and the North-western Provinces, and impoverished the people of these districts to some extent, and hence diminished their capacity to resist the effects of the deficient rainfall and drought in the succeeding years 1895 and 1896.

Deficient rainfall during the wet monsoon is, undoubtedly, the most potent factor in diminishing the staple food crops of India and leading up to food scarcity and famine. The rainfall may be deficient throughout the whole season, as was the case in many districts of the North-western Provinces in the south-west monsoon of 1896; or the rains may cease suddenly and abruptly some weeks earlier than usual, as in the Central Provinces in 1896. In the latter case, prospects may be excellent from the beginning of the monsoon up to the middle or end of September, and then deteriorate rapidly in consequence of the failure of the rainfall necessary for the full growth of the rice and other food crops. This was the case in 1896 over the greater part of the Central Provinces and Bengal, where the partial failure of the rice crop was solely due to the absence of rain in October and November 1896.

The failure of the crops in India, 1896, was more extensive, and spread over a far wider area than has occurred for probably 100 years at least, and its effects were intensified by the four unsatisfactory seasons which preceded it. It was due in a few districts to excessive rain and floods, in a large number of districts to scanty rainfall throughout the whole monsoon, and in others to the early and abrupt termination of the rains from a month to six weeks before the normal date.

The following gives details and data of the more important abnormal features of the south-west monsoon rains of 1896, which were chiefly instrumental in leading up to the very general and partial failure of the summer or wet crops of that year. The table below gives the average or normal date on which the south-west monsoon rains commence in different provinces of India, and the mean date on which they commenced in the same areas in 1896:—

Province	Normal or average date of commencement of south-west monsoon rains	Mean date of beginning of south-west monsoon rains. 1896	Variation from normal date
Bombay (West Coast Districts)	June 5	June 14	9 days later than usual
Central Provinces	,, 10	,, 17	7 ,, ,,
Central India ...	,, 15	,, 21	6 ,, ,,
Rajputana... ...	,, 15	,, 21	6 ,, ,,
Bengal	,, 15	,, 18	3 ,, ,,
Bihar	,, 15	,, 19	4 ,, ,,
North-west Provinces and Oudh	,, 25	,, 21	4 days earlier than usual
East Punjab ...	July 1	,, 25	6 ,, ,,

This table shows clearly that the advent of the monsoon was slightly delayed, more especially in the Arabian Sea and on the west coast of India. The monsoon currents advanced, however, so rapidly into the interior that in Upper India the rains began a few days earlier than usual, establishing that the local conditions in India were favourable. (This was anticipated in the Departmental forecast published in the first week of June antecedent to the arrival of the monsoon, in which it was stated "that the monsoon currents would probably set in on the Bombay coast later than usual, but would advance into the interior more rapidly than usual.")

The monsoon currents held without any general break or interruption throughout the remainder of the month of June, and also during the whole of July and the first three weeks of August, but were less steady than usual. A larger number of cyclonic storms than usual formed in the Bay during this period, as is the rule in a weak monsoon. These storms advanced in the same general direction across a broad belt of country at the head of the Peninsula, stretching from Orissa to Gujarat and Kathiawar. The in-draught to these storms affected the dis-

tribution of the rainfall in two respects: it diminished the rainfall in Bengal and the Gangetic Plain, and distributed it more largely and copiously in cyclonic downpours over the areas traversed by these storms, viz. Orissa, the southern districts of Chota Nagpur, the Central Provinces, Berar, the south-western districts of Central India and Rajputana, Gujarat, and Kathiawar.

The following comparative statement indicates roughly but clearly the distribution of the rainfall during this period from the commencement of the rains to the end of August:—

	Province	Rainfall of period June 1 to August 31			
		Average actual (1896)	Average normal	Variation from normal	Percent. variation
		Inches	Inches	Inches	Percent.
Areas of deficient rainfall	Bengal ...	33·69	44·55	−10·86	−24
	Assam ...	43·91	54·53	−10·62	−19
	Bihar ...	25·67	32·88	−7·21	−22
	North-west Provinces ...	22·42	26·69	−4·27	−16
	Oudh ...	22·47	26·33	−3·86	−15
	Punjab ...	9·99	12·14	−2·15	−18
	Rajputana ...	13·59	16·03	−2·44	−15
	Central India ...	28·82	33·28	−4·46	−13
	Hyderabad, North ...	21·82	22·34	−0·52	−2
	Madras Deccan ...	7·62	10·08	−2·46	−24
Areas of increased or excess rainfall	Orissa ...	45·62	32·85	+12·77	+39
	Chota Nagpur ...	42·16	36·31	+5·85	+16
	Central Provinces ...	51·19	35·69	+15·50	+43
	Berar ...	24·28	24·05	+0·23	+1
	Gujarat ...	45·00	34·00	+11·00	+32
	Kathiawar ...	28·51	20·81	+7·70	+37
	Bombay Deccan ...	31·60	21·34	+10·26	+48
	Madras East Coast North	20·71	18·71	+2·00	+11

The data establish that over the broad belt of country between Orissa and the North Bombay coast, including Orissa, the Central Provinces, the Bombay Deccan, Gujarat, and Kathiawar, the rainfall of the monsoon up to the end of August was in large excess, by amounts averaging from 30 to 50 per cent. It was, on the other hand, in defect by nearly equal percentage amounts over the whole of India to the north of that belt, *i.e.*, in Bengal, Bihar, the North-western Provinces, Central India, Rajputana, and the Punjab. It is assumed in the rainfall maps prepared weekly for the Government of India that a seasonal deficiency in a meteorological district or province of 20 per cent. or upwards is large, and that the crops in such an area will be seriously affected unless the rainfall is very favourably distributed throughout the whole season. The data hence show that the rainfall during the period June to August 1896 in Bengal, Bihar, and the Madras Deccan was in serious deficiency, and that it was also in marked defect in the provinces of Assam, the North-western Provinces, the Punjab, Central India (east), and Rajputana, by amounts verging on what may be termed the danger line. It should, however, be noted that, although the rains over the greater part of Northern India were scanty, they had been on the whole favourably distributed (more especially in Bihar and Bengal), and the chief food crops in these districts only required moderate and seasonable rain during the next six or eight weeks in order to give a fair to satisfactory outturn. The rice crop in Bihar, the eastern districts of the North-western Provinces, the Central Provinces, and Bengal especially, requires fair rain in September to complete its growth. Unfortunately, the rains at this critical period, in September 1896, failed almost entirely in Northern and Central India in consequence of the abnormally early retreat of the humid monsoon currents and the prevalence of dry, clear, and much warmer weather than usual in September and October, at a time when occasional rain is essential.

The monsoon currents withdrew from the whole of Northern and Central India from four to seven weeks earlier than usual, in August and September 1896, as shown in the following table. The conditions and features of the withdrawal and retreat of the current were practically normal in all other respects. The table gives data showing the very early termination of the rains.

Province	Normal or average date of termination of south-west monsoon rains	Mean date of termination of south-west monsoon rains, 1896	Monsoon closed earlier than usual by
East Punjab ...	September 15	August 22	24 days
North-Western Provinces and Oudh ...	„ 30	„ 30	31 „
Bihar	October 15	September 18	27 „
Bengal	„ 31	„ 21	40 „
Rajputana ...	September 20	August 18	33 „
Central India ...	„ 30	„ 28	33 „
Central Provinces	October 15	„ 31	45 „
Bombay ...	„ 15	„ 31	45 „

The preceding data establish that the monsoon rains ceased from three to six weeks earlier than usual, and also that this acceleration was greatest in the rice-growing districts of Bengal, the Central Provinces and Bombay, where it was most prejudicial in its effect on the staple crops.

The general failure of the rains in September and October 1896, is shown most fully by the data of the following table:—

Province	September 1896		October 1896	
	Variation of rainfall of month from the normal	Percentage variation of rainfall of month from the normal	Variation of rainfall of month from the normal	Percentage variation of rainfall of month from the normal
	Inches		Inches	
Assam	−0·23	−2	−3·16	−65
Bengal	+0·85	+8	−3·94	−87
Bihar	−2·38	−28	−2·66	−99
Chota Nagpur	−3·43	−41	−2·92	−100
North-western Provinces	−5·82	−91	−1·47	−99
Oudh	−6·55	−95	−1·59	−99
Punjab	−2·04	−78	−0·22	−65
Berar	−5·85	−94	−2·29	−99
Central Provinces ...	−6·45	−79	−1·98	−100
Central India	−6·12	−93	−1·66	−100
Rajputana	−2·17	−87	−0·26	−89
Gujarat	−6·28	−78	−1·36	−100
Kathiawar	−4·19	−89	−0·69	−100
Bombay Deccan ...	−4·33	−78	−4·19	−84
Madras, Central ...	−2·98	−56	−4·85	−93
„ East Coast North	−1·97	−28	−6·96	−98
Hyderabad, North ...	−5·74	−76	−2·43	−89

The preceding data show clearly the very serious deficiency of rain in September and October. Thus in the month of September, the rainfall over the whole of India north of lat. 12°, with the exception of Assam, Bengal, Bihar, Chota Nagpur and North Madras, was only one-seventh or 14 per cent. of the normal amount, and in the month of October the rainfall over the whole of India north of lat. 14° was less than one-twelfth of the normal, and over the greater part of the area, including Bihar, Chota Nagpur, North-western Provinces, Oudh, Berar, the Central Provinces, Central and North Madras, Gujarat and Kathiawar, the rainfall of the month was practically or absolutely *nil*.

It will thus be seen that in the large area including Bengal, Bihar, the North-western Provinces, Punjab, Rajputana, Central India (east), the wet or south-west, monsoon crops (usually called the kharif) failed to a more or less serious extent: (1) from deficient rainfall throughout the season; (2) from the abnormally early and abrupt termination of the monsoon rainfall three to seven weeks earlier than usual. In another large area including Berar, the Central Provinces, and the greater part of the Deccan and North Madras, although the rainfall during the first three months of the monsoon was more abundant than usual, the early termination of the monsoon, about six weeks earlier than usual, affected the crops almost as seriously as in the first area, including the greater part of Northern and Central India.

The preceding discussion has shown the chief features of the south-west monsoon of 1896, which made it so disastrous a season for the staple food crops in India.

It is natural to inquire whether the deficiency of rainfall in India accompanied a greater determination of the monsoon currents towards, and hence heavier rainfall in, the remaining land areas of the monsoon region.

The chief land areas which obtain, in general, moderate to heavy rains from the south-west monsoon winds (the continuation of the south-east trades of the Indian Seas) are: (1) India; (2) Burma, Siam and the Malay Peninsula; (3) the equatorial lake region of Central and East Africa and the Abyssinian highlands.

In nine years out of ten, when the rainfall is in marked defect in Northern India, it is more or less in excess in Burma; and the monsoon of 1896 was no exception to the rule, as is shown by the following:—

Division	Rainfall from May 31 to October 17, 1896			
	Average actual	Average normal	Variation from normal	Percentage variation
	Inches	Inches	Inches	
Tenasserim	183·86	154·58	+29·28	+19
Lower Burma (Deltaic).	106·59	81·57	+25·02	+31
Arakan	161·74	156·86	+ 4·88	+3

The very limited information I have received indicates that the precipitation was also in excess in Siam.

Information of the rainfall in the third region of summer monsoon rainfall has not yet reached India. I am, however, informed that the curve showing the flood level of the Nile at the gauge stations at Assuan and at the Barrage, near Cairo, at the head of the Delta, for the past year was most unusual. Instead of having one maximum in September, as is usually the case, it presented two well-marked maxima, the first being the ordinary and absolute maximum in September, and the second an abnormal and secondary maximum in November, apparently due to heavy rainfall in October in Abyssinia. Heavy rain is reported to have fallen in the Upper or White Nile Basin in November. The defection of the humid current indicated by this fact is confirmed by the unusual and abnormal easting of the winds in October and November at the Seychelles and Zanzibar. This heavy rainfall hence occurred in the African region at the time when the retreating south-west monsoon was giving unusually scanty rain in Southern India and the Deccan.

It is also probable that the rainfall in the sea area passed over by the monsoon currents in their advance towards India may have been greater than usual. Mr. Blanford, in his monograph on the rainfall of India, has laid down the following principle: "that it is not when the monsoon current is blowing steadily that rain is most probable, but when it is defected from its normal direction by some local irregularity of pressure."

It is not possible at the present time to obtain direct evidence on this point. The rainfall of the Seychelles and Zanzibar during the period June to September of the past five years has, on the whole, varied inversely to that of the same period in India, thus slightly in favour of the assumption that the rainfall in the sea area was somewhat larger than usual during the past two years, and more especially in 1895.

So far as can be judged from the limited data available, it is almost certain that the distribution of the rainfall in the whole monsoon land region has not been compensatory, and hence that the precipitation has, from some unknown conditions or actions, been below the nórmal to a considerable extent, probably more than 5 per cent. of the average of the whole area. It is not possible to infer whether this deficiency has been compensated by a heavier precipitation over the equatorial belt of the Indian Ocean and over the Arabian Sea and Bay of Bengal. The data for the insular stations of Port Blair, Minicoy, Amini Devi and the Seychelles are certainly opposed to this supposition.

It is hence almost certain that the deficient rainfall in India in the past year, 1896, is only a phase of conditions and actions extending over a much larger area.

The variations in the amount and distribution of rainfall in India during the past five years, 1892–6, cannot be explained by the local meteorological conditions, either antecedent to or during the monsoon, and are, in fact, of such a character as to indicate that they are probably mainly due to corresponding variations in the strength of the south-east trades, of which the south-west monsoon circulation is the northward extension from June to October. As the strength of a steady horizontal air movement is directly related to the pressure gradients, the variations of the latter, which are approximately known from the pressure data of the Observatories at Mauritius, Zanzibar, the Seychelles, and Colombo, may be employed to indicate roughly the variations in the strength of the south-east trades from 1892–6.

The following gives the mean differences of pressure between Mauritius and Zanzibar, Seychelles and Colombo (1) for the period June to August, and (2) for the period June to October of each year from 1891 to 1896:—

Year	Mean pressure difference of period June to August		
	Mauritius to		
	Colombo	Zanzibar	Seychelles (observatory opened 1894 April)
	″	″	″
1891	·321	·071	
1892	·339	·087	
1893	·377	·104	
1894	·335	·078	·221
1895	·334	·065	·215
1896	·350	·099	·236
Normal difference...	·335	·080	·230

Year	Mean pressure difference of period June to October		
	Colombo	Zanzibar	Seychelles
	″	″	″
1891	·312	·091	
1892	·324	·102	
1893	·339	·116	
1894	·305	·090	·205
1895	·308	·075	·201
1896	·319	·105	·220
Normal difference...	·310	·095	·210

The preceding data establish conclusively that the mean pressure differences or gradients in the south-east trades region during the south-west monsoon periods of the past five years, 1892–96, exhibit a similar law of variation to that of the rainfall of India. The gradients or pressure differences were above the normal in 1892, 1893, and 1894, reaching their maximum normal in 1893, and considerably below their mean value in 1895. The figures seem to indicate that the maximum and minimum pressure effect precede by some months the maximum and minimum rainfall in India, a very important indication if further experience should show it is a general rule and not a casual coincidence.

The variations of gradient almost certainly indicate corresponding variations in the strength of the south-east trades. That there are variations in the strength of the south-east trades has been suggested by Mr. W. E. Hutchins, Conservator of Forests to the Cape Government, in explanation of the variations of rainfall from year to year in the Cape Colony. In a letter (written in April 1896), which I received from him in June, and sent for publication to several of the Indian newspapers, he says: "The absence of the south-east trades in the Cape throughout the past summer (*i.e.* November 1895 to March or April 1896) has brought abnormal summer rains to the Cape Peninsula, and drought, scarcity and locusts to the bulk of the continent, where the usual summer rains have failed. Are

the south-east trades at present deficient in energy? The south-west monsoon in India is held to be an extension of the south-east trades. After what has happened in South Africa it will be interesting to note the character of the coming monsoon in India. There are two indications pointing to the failure of the coming Indian monsoon (in 1896).

"(1) The failure of the south-east rains in South Africa.

"(2) The cyclical variation of weather in South Africa."

Mr. Hutchins' anticipations were unfortunately fully verified, and confirm the probability of the relation between the varying strength of the south-east trades and the monsoon rainfall of India.

I have recently had my attention called, by Captain Froud, Secretary to the Shipmasters' Society, to the presence in large numbers of icebergs in the Antarctic Ocean, much further north than usual, off the Cape Colony coast, to such an extent, in fact, as to be dangerous to steamers following the "safety track" from London to New Zealand, adopted by several English steamer lines. One vessel met with icebergs as far north as lat. 35° N., and numbers, said to be from 400 to 600 feet above water, have been encountered by steamers during the past eighteen months, at least, in lat. 42° to 45° S., to the south, south-east and south-west of the Cape. The following give extracts from the log of the s.s. *Thermopylæ*:—

1896.	Lat. S.	Long. E.	
September 22 ...	45° ...	49° ...	Passed iceberg ½ mile long and 640 feet high.
,, 23 ...	— ...	— ...	Very large icebergs, with perpendicular sides and flat top, ¾ mile long and 400 feet high.
,, 24 ...	— ...	— ...	Passed two large icebergs and many small pieces.
,, 25 ...	46° ...	70° ...	Several large icebergs seen.
,, 26 ...	46½° ...	75° ...	Last iceberg seen.

formerly, thereby increasing the risk of the southern passage to Australia."

Mr. Allingham, of the English Meteorological Office, has kindly supplied me with a summary, tabulated below, of the data he has collected, indicating the abnormal number and northward extension of icebergs in the south-east of the Indian Ocean during the past two years.

The following summarises the chief features of the remarkable cyclonic variation of rainfall in India during the past five years, and which culminated in partial failure of the crops and scarcity over so wide an area in 1896:—

Year	Rainfall			
	Mean actual	Mean normal	Variation from normal	Percentage variation
1892	46·18	41·09	+ 5·09	+ 12
1893	50·16	41·09	+ 9·07	+ 22
1894	47·56	41·09	+ 6·47	+ 16
1895	38·90	41·09	− 2·19	− 7
1896	36·26	41·09	− 4·83	− 12

If single stations, in the province most largely affected by the abnormal condition of the period, were selected, the contrast between the excess in the years 1892–94 and the deficiency of the years 1895–96 is very marked. The table at the top of p. 115 gives data of total rainfall of period June to October at one station in the Central Provinces, one in the North-western Provinces, and one in Bihar, in illustration of this.

At Allahabad, the headquarters of the Government of the North-western Provinces, the area most seriously affected, the total rainfall in 1894 was practically double the normal, and in 1896 barely half of the normal.

Ship	Date	Position	Number of icebergs seen	Remarks
s.s. *Thermopylæ* ...	June 24, 1895	45° S. 49° E.	12	Some 400 feet high
Armida ...	July 9, 1895	42 S. 43 E.	1	400 feet high
s.s. *Zainui* ...	July 10, 1895, to July 13, 1895	44 S. 45 E. to 45 S. 67 E.	13	100 feet to 200 high
Gainsborough ...	July 15, 1895, to July 17, 1895	42 S. 43 E. to 42 S. 51 E.	5	
s.s. *Port Chalmers* ...	July 27, 1895	45 S. 52 E.		Steamer collided with an iceberg
Queen Mab ...	Aug. 6, 1895	35 30′ S. 20 45′ E.	7	70 feet to 200 feet high
s.s. *Kaikoura* ...	Nov. 17, 1895	45 S. 52 E.	1	Very large
s.s. *Gulf of Lions* ...	Dec. 23, 1895	47 S. 50 E.	1	130 feet high
s.s. *Buteshire* ...	Aug. 5, 1896, to Aug. 7, 1896	45 S. 55 E. to 46 S. 66 E.		Several, mud loose in
s.s. *Thermopylæ* ...	Sept. 22, 1896, to Sept. 25, 1896	45 S. 50 E. to 46 S. 71 E.	30	300 feet to 640 feet high (640 feet by sextant)
s.s. *Tongariro* ...	Oct. 1896	45 S. 50 E. to 47 S. 80 E.	200	Some very large
Loch Fergus ...	Oct. 13, 1896, to Oct. 20, 1896	45 S. 50 E. to 46 S. 78 E.		Numerous icebergs
Firth of Lorn ...	Oct. 27, 1896	43 S. 57 E. to 43 S. 59 E.	3	300 feet high
s.s. *Otarama* ...	Nov. 3, 1896, to Nov. 7, 1896	46 S. 54 E. to 47 S. 77 E.	336	Mud small
s.s. *Stassfurt* ...	Nov. 29, 1896, to Dec. 1, 1896	44 S. 68 E. to 45 S. 79 E.	3	50 feet, 70 feet, 250 high
s.s. *Matatua* ...	Nov. 9, 1896, to Nov. 14, 1896	45 S. 52 E. to 46 S. 81 E.	57	One 420 feet high
s.s. *Pakeha* ...	Dec. 3, 1896, to Dec. 10, 1896	45 S. 50 E. to 45 S. 80 E.		Very many

The captain adds that measurements were carefully taken by the sextant when the icebergs were suitably situated near the track of the vessel.

The captain of the s.s. *Port Melbourn*, in a letter dated London, February 11, 1897, writes: "On our passage out last voyage to Albany (Western Australia), we encountered a number of large icebergs (about forty-five in all) and a quantity of smaller pieces of ice between lat. 44° S. and 45° S. and long. 49° E. and 70° E. The larger icebergs ranged from ¼ mile to 2 miles in length and from 300 feet to 820 feet in height (as measured by the sextant). It is very evident that ice in the Southern Indian Ocean now appears to work its way further north than

The data hence show that there was a strongly marked cyclical variation of the rainfall of India in this period, the maximum of which was 1893, and the minimum (probably) in 1896. In the year of maximum rainfall (1893), the south-west monsoon commenced early and withdrew much later than usual, and gave excessive rain throughout the whole period of its prevalence, whilst that of 1896, the year of minimum rainfall, commenced late, withdrew early, and gave scanty and very deficient rain throughout the whole period. The marked contrast between the two years was, it may be noted, not restricted to the south-west monsoon. In 1893 and 1894 the rainfall was above the normal in each of the four seasons into

Station	Normal rainfall in use previous to 1894	Normal rainfall in use since 1894	1892		1893		1894		1895		1896	
			Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal
Suegor	41·03	45·67	47·21	+ 6·18	61·50	+ 20·47	69·96	+ 24·29	42·16	− 3·51	37 13	− 8·54
Allahabad	33·43	37·00	32·92	− 0·51	45·94	+ 12·51	69·60	+ 32·60	25·94	− 11·06	19·93	− 17·07
Motihari	42·52	47·60	65·16	+ 22·64	79·31	+ 36·79	43·12	+ 0·60	57·29	+ 14·77	28·84	− 18·76

which the year is divided in India, whereas from March 1895 to March 1896 it was more or less in defect in each season, as is shown by the data of the following table.

The variations in this table are calculated from the data of over 2000 stations for which normal monthly means have been calculated, and no allowance is made for the area represented by each station. The total annual variation hence varies considerably according to the two methods of calculation, but it will be seen that they agree in the general character of the cyclical variation :—

Year	Rainfall variation of whole of India (excluding Burma)				
	January and February	March to May	June to Sept.	November and December	Of whole year
	Inches	Inches	Inches	Inch	
1892	−0·37	+0·42	+4·39	−0·96	+3·48
1893	+1·42	+3·62	+3·39	+0·49	+8·82
1894	+0·53	−0·10	+7·56	+0·31	+8·30
1895	+0·04	−0·08	−3·27	−0·72	−4·03
1896	−0·45	−1·09	−3·80	+0·33	−5·01

The main features of the rainfall during this period were hence not special to the south-west monsoon, but general and affecting the meteorology of the whole year. This fact indicates that the causes of the periodic variations are not only general, but due to more or less permanent and persistent meteorological conditions or actions affecting the meteorology of the whole period over a considerable portion of the earth's surface.

It has apparently been established in the discussion that the variations of the rainfall in India during the past six years are parallel with and in part, at least, due to variations in the gradients, and the strength of the winds in the south-east trade regions of the Indian Ocean. The discussion has indicated that there are variations from year to year in the strength of the atmospheric circulation obtaining over the large area of Southern Asia and the Indian Ocean, and that these variations are an important and large factor in determining the periodic variations in the rainfall of the whole area dependent on that circulation, and more especially in India. It has also been indicated that these variations which accompany, and are probably the result in part of abnormal temperature (and hence pressure), conditions in the Indian Ocean and Indian monsoon area may be in part due to conditions in the Antarctic Ocean, which also determine the comparative prevalence or absence of icebergs in the northern portions of the Antarctic Ocean.

The economic effects of these very large variations of rainfall during the past five years has been very great, almost disastrous, in India. The variations are so large in amount, and affect so vast an area, as to suggest that meteorological science should have no difficulty in assigning the causes or chain of actions leading up to these effects. Facts have been given in the present paper which suggest an explanation, but it is doubtful whether it can be regarded as satisfactory.

There appear to be only two explanations possible of this periodicity. The first is that it represents large cumulative effects of opposite phases in different parts of the earth. So far as the whole Indian monsoon area is concerned, the variations in different parts have not been compensatory; and the rainfall in 1896 has almost certainly been below the normal, on the mean of the whole area. It would be an interesting study for a Central International Weather Bureau to investigate. So far as can be judged from a brief examination of the weather reports of other countries, there appear to have been no large and marked periodic variation in other parts of the world corresponding to the variation in India—of either the same or opposite phase. It is hence, on the whole, probable that the periodic rainfall variation of the past five years in India has not been compensated by a similar variation of opposite phases elsewhere. If it were the case, it would be purely a question of meteorological investigation.

The second explanation is that this periodic variation of rainfall in the Indian Ocean during the past five years may be one phase of general actions in the earth's atmosphere, due to abnormal variations in the radiation and absorption of solar energy, and hence to some abnormal phase of the sunspot periodicity. Perhaps the observations recorded at Solar Physics Observatories during the past five years may throw light on the question; and if such be the result, it would furnish a powerful argument for India assisting in the work of Solar Observatories to a much larger extent than she has hitherto done.

The question which now affects India most seriously is, whether the rainfall of the present monsoon is likely to be seriously in defect.

An examination of the figures certainly indicates a probability that the mean rainfall of the year will be below the normal. If the causes of the variations were known with certainty, it would probably decide the question. J. E.

THE INSTITUTION OF CIVIL ENGINEERS.

ON Tuesday, Wednesday, and Thursday of last week, May 25, 26, and 27, the Institution of Civil Engineers held a conference. This is a thing unprecedented in the annals of the Institution, it having confined itself hitherto to weekly meetings during the London season. Not only were there daily sittings, many of them proceeding simultaneously, for the reading and discussion of several papers, but there were also excursions to works and "other objects of interest." There was, as well, a conversazione; but this is no novelty for the Institution. A very large number of members attended the meetings, the Westminster Town Hall and the Westminster Guildhall having been retained for the purpose. The general plan of the conference was for one or more members to read a short note by way of initiating a discussion. As there were nearly fifty items in the programme, the congress being divided up into seven sections, it will be evident that in the small space at our disposal we cannot even refer to all the subjects brought forward.

Proceedings commenced at half-past ten on Tuesday, May 25, by the President reading a short address in the Westminster Town Hall, in which the scope of the conference was sketched out. The members then dispersed to the different sections. Section I. was devoted to railways, and the proceedings commenced by Mr. Harold Copperthwaite reading a note on rails and permanent way. He was followed by Mr. F. W. Webb, of Crewe, who read a note on the same subject. The discussion was of an entirely practical and professional nature. Mr. Webb introduced a model of a joint chair; that is to say, a device which combined in itself a rail chair and fishplate. It will be a great boon to railway travellers if this apparatus can be introduced, supposing it will fulfil all the promises made on its behalf by its originator, for there is no doubt that a very great part of the jar and rattle of railway travelling is due to the giving of rails at the joints. This fact was illustrated by means of lead fishplates, which Mr. Webb had used for the purpose of showing what was the amount of deflection at rail connections; it was considerable. The joint chair referred to is of massive construction, and care will have to be taken that too much progress is not made in the direction of rigidity, otherwise there will be repeated the old trouble experienced with stone blocks for sleepers; some flexibility is needful for a good road. In

Section II. there were also two subjects introduced, the first relating to concrete in marine works, and the second in relation to approaches of docks. Sections III. and VII. sat conjointly, the former of these two dealing with machinery, and the second with applications of electricity. Messrs. Preece, Ellington and Dr. Hopkinson contributed the notes which opened the discussion; the combined subject for the day being the transmission of power by electricity, by water, and by other agents. Mr. Ellington naturally claimed that water was superior to electricity, a statement which was equally naturally disputed by the electricians present. It is needless to say nothing definite was settled on this many-sided question. Perhaps the most interesting contribution to the discussion was that supplied by Prof. Forbes, who had come to the conclusion that the distance over which power might be profitably transmitted by electricity was not far short of 1000 miles. He had been consulted as to the transmission of power from the Victoria Falls on the Zambesi to the gold mines in Matabeleland and the Transvaal. At first he considered the suggestion altogether impracticable; but on putting together figures with a view to prove its absurdity, some ideas had occurred to him which led him to believe that the scheme was not so chimerical after all. The electrical world will look forward with interest to the development of Prof. Forbes' plans.

The proceedings in Section IV., which deal with mining and metallurgy, were of a very practical nature. The most interesting of the contributions was that by Mr. Bennett H. Brough, in which he gave some interesting particulars of deep mines in the United Kingdom. At Pendleton Colliery, near Manchester, the workings were 3474 feet below the surface, that being the deepest working in Great Britain. The deepest metal mine in the United Kingdom is the Dolcoath Tin Mine in Cornwall, which is 2582 feet deep. These figures are, of course, exceeded in mines abroad; a shaft in the copper mines of the Lake Superior district, the deepest in the world, going down to 4900 feet.

Section V. was devoted to shipbuilding. The proceedings were opened by a very instructive note by Mr. Archibald Denny, of Dumbarton, in which he dealt with the practical application of model experiments in merchant ship design. As is well known, Mr. Denny's firm have the only experimental tank of a private nature in the world, it being modelled after the design of the late Mr. Froude. Mr. Denny gave a description of the method of procedure in carrying out these model experiments. A very good discussion followed the reading of this paper, in which Mr. R. E. Froude, Sir Edward Reed, Mr. Thornycroft, Prof. Biles, Sir William White, and others took part. Section VI. was devoted to waterworks, sewerage, and gas works. On the first day of the meeting the proceedings were devoted to a consideration of the law of allocation of underground water.

On the second day of the conference, Wednesday, May 26, in Section I. (the railway section), the discussions turned chiefly on the economics of light railways. In Section III. the most interesting paper was that contributed by Mr. Bryan Donkin, on "Important Questions in the Economic Working of Steam Engines and Boilers." The author pointed out that for greater efficiency it was desirable to adopt high pressures up to 250 pounds, efficient steam-jacketing, reduction of clearance volumes in surfaces of cylinders, and a high number of revolutions. He pointed out that moderately superheated steam had long been employed on the continent, but was coming into favour here very slowly. Superheating reduces cylinder condensation, but, of course, is attended by practical difficulties, and requires more highly-skilled attendance. Mr. Donkin also impressed on the meeting the advantage of using entropy diagrams. He stated that multi-cylinder engines, with twenty or thirty expansions, are very economical, but are only admissible where the barrels and covers are thoroughly steam-jacketed, or superheated steam is used. He also advised greater compression than is generally used. He advocated the statement of economy in terms of thermal units per I.H.P. hour, and also in thermal units per break H.P. hour, whether for saturated or superheated steam. In dealing with steam boilers he pointed out the need of analyses of gases to determine the percentage of CO_2, CO, and O. He rightly stated that no boiler experiments are complete without such gas analyses. Reference was also made to the use of coal finely ground, which, it is said, was being used on the continent. The information is interesting, remembering the great efforts made many years ago to use powdered coal, and the difficulties which led to the failure of the scheme. It would be interesting to know how these difficulties had been overcome. This note concluded by an advice that all engine and boiler trials should be tabulated in uniform manner. It is satisfactory to know that the subject is likely to be taken up by the Institution. A speech which the President, Mr. Wolfe Barry, made, gives hope that a Committee will be formed to consider and report on this matter, and it is probable some legislation by the Institution will follow. In order, however, to make the Committee complete it should take a wider range than the Institution of Civil Engineers, which, although our premier engineering society, is not the only representative engineering body, more especially in regard to mechanical engineering. Petroleum as a steam-engine fuel was the subject introduced by Mr. Aspinall, the Locomotive Superintendent of the Lancashire and Yorkshire Railway. An interesting discussion followed the reading of this note, but it took rather a practical than a scientific turn. There is no doubt that liquid fuel can be used with great convenience on locomotives, and would speedily supplant coal if it could be obtained in sufficiently large quantities and at a sufficiently low price. At present it is only now and then that it can be economically used; still the Great Eastern Railway have a number of liquid-fuel-burning locomotives in fairly constant use on their system.

The Electrical Section on this day discussed two subjects—namely, "Should generating plant be mounted on springs?" and "Turbines as applied to dynamos." In regard to the former, it may perhaps be said that the gist of the discussion pointed to the fact that when generating plant has been mounted on springs, the results have not been altogether satisfactory; but, nevertheless, by mechanical improvements and alterations in detail, the system might be sufficiently perfected to enable it to be worked advantageously. The problem of using turbines was introduced by the Hon. C. A. Parsons. The subject is an interesting one, and the author was well able to deal with it had he been allowed further time. As it was, the note was decidedly meagre, and the discussion disappointing. Perhaps the paper of most interest on this day was that read in the Shipbuilding Section, by Mr. Parsons, in which he gave some particulars of the wonderful steam-turbine-driven boat which he has recently designed and built. The *Turbinia*, the boat in question, is 100 feet in length, 9 feet wide, and 3 feet draught amidships, having a displacement of 44½ tons; she is, therefore, only half the length, and of very greatly less displacement, than the torpedo-boat destroyers, which have been, hitherto, our fastest vessels. With this little boat, however, Mr. Parsons has made a speed of 32¾ knots; but he anticipates that when some alterations have been made in the machinery, still higher speeds will be reached: we believe up to 34 knots. There is a water-tube boiler and three steam-turbines working on the compound system in series. Each of these turbines has its own propeller shaft, and on each shaft there are three screws threaded in line. The most remarkable part of the machinery is that the propellers make 2200 revolutions per minute, in order that they may be worked direct from the steam-turbines, which must necessarily revolve at a high speed. The I.H.P. is 2100, and the consumption of feed water per I.H.P. per hour, 14½ lbs. The weight of the main engines is 3 tons 13 cwt., and the total weight of machinery, including water in boiler, &c., 22 tons. Thus nearly 100 H.P. is developed per ton of machinery, and nearly 50 H.P. per ton of displacement of boat; it need hardly be said that the figures are unprecedented.

On the last day of the meeting a large number of papers were read; to these we can only make brief reference. In a discussion on ball and roller bearings, Prof. Goodman gave some interesting details of experiments he had made with a bearing having an 8-inch diameter ball-race of the thrust-block type, which ran at 1600 revolutions. He had tried the system of using four points of contact between the ball and race, which had been advocated by a correspondent to a technical journal, and which was said to give the perfect rolling contact, but had found that the system would not work satisfactorily; and it was only when he fell back on the more ordinary double-contact system, that he met with success. A paper by Prof. Biles, in the Shipbuilding Section, on "Improved Materials of Construction," led to an interesting discussion, in the course of which a good deal was said about nickel steel, which is certainly the coming material for shipbuilding if the question of price can be satisfactorily settled; to effect which further deposits of nickel must be discovered and worked economically. In the Harbour and Docks Section, the Hon. R. C. Parsons described an automatic dredg-

ing machine he had devised. There was a good discussion on the decimal system, initiated by a note by Captain Sankey; and to the same section, Mr. Spagnoletti contributed a note on the equilibrium system of feeding electric railways. There were two good papers in the Railway Section: one on "Standardising of working loads and working stresses for railway bridges," and the other on "The use of small scale experiments in some engineering problems." These were contributed by Mr. Moncrieff and Mr. Mallock respectively.

THE POPULATION OF RUSSIA.

THE results of the first one-day census, which was made throughout the width and breadth of the Russian Empire on February 9 last, were expected with great interest. The last census was made in 1851, and a partial one in 1858; and yet it was not a census proper, for the local police authorities on the spot merely made lists of the permanent residents and taxpayers in each locality. After much preparatory work, it was decided to make, this year, a "one-day census"; that is, in the lists which had to be made for each house in each locality, all those persons who spent the night in a given house and in a given locality on February 9 (or about that date in the villages), had to be mentioned, whether they were permanent residents or not. It was quite a novel experiment, which was looked at with little confidence; but the Vice-President of the Russian Geographical Society, who had had already a great deal of experience with such censuses as they were made, since 1870, in separate big towns (in these censuses the illiterate population filled their lists, as a rule, admirably well), insisted upon the new method being accepted. The census was organised under his guidance, and seems, so far as can be judged, to have been quite successful. The items, obtained from all the local committees, partly by telegraph—with the exception of some parts of the province of Yakutsk—are now published; and the population of the empire appears from them as follows:—European Russia, 94,188,750; Kingdom of Poland, 9,442,590; Grand Duchy of Finland (Finnish yearly census), 2,527,801; Caucasia, 9,723,553; Siberia and Sakhalin, 5,731,732; the Kirghiz Steppes, 3,415,174; Turkestan, with the Trancaspian Region and the Pamirs, 4,175,101; Russian subjects in Bukhara and Khiva, 6412; total, 129,211,113. The corresponding figures, in 1851, were: European Russia, 52,797,685; Poland, 4,852,055; Finland, 1,636,915; Caucasia, 4,436,152; Siberia, 2,437,184; Steppes, 1,220,654; total, 67,380,645. It may thus be said that although the percentage of births is very high in Russia, it took nearly fifty years for the population to double.

An English writer about Russia made, some time ago, the remark that Russia suffers from *a polism*, that is, from a want of towns. This want has lately very much disappeared. There are now in the empire no less than 19 towns having a population of more than 100,000 (out of which two in Poland, two in Caucasia, and one, Tashkend, in Turkestan); 35 towns with populations from 50,000 to 100,000; and 69 towns with populations of from 25,000 to 50,000. St. Petersburg has already attained the figure of 1,267,023, and Moscow approaches the million (988,610).

It is worth mentioning that no less than 230,000 persons took part in the census; very many of them were volunteers, who were recruited among the students of the Universities and the High Schools.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. H. A. Miers, F.R.S., and Mr. W. Garstang, have been appointed examiners for the Burdett-Coutts Scholarship.

An examination for one or more Natural Science Demyships and Exhibitions will be held at Magdalen College in October. The value of the Demyships is £80 per annum. Candidates must be under nineteen years of age on the day of election, October 18.

The Right Hon. John Morley delivered the Romanes Lecture in the Sheldonian Theatre on Wednesday last. The subject was Machiavelli.

CAMBRIDGE.—Dr. Alex. Hill, Master of Downing College, and University Lecturer in Anatomy, has been elected Vice-Chancellor for the ensuing academical year.

Dr. R. D. Roberts has been appointed a Governor and Member of Council of the University College of Wales, Aberystwyth.

The first Smith's Prize has been awarded to Mr. E. T. Whittaker (bracketed second wrangler 1895), of Trinity College, for his essay on "Multiform Functions." The second prize is divided between Mr. R. C. Maclaurin (twelfth wrangler 1895), of St. John's College, for his essay on "Solutions of the Equation $(\nabla^2 + \kappa^2)\Psi = 0$ in Elliptic Co-ordinates," and Mr. A. E. Western (seventh wrangler 1895), of Trinity College, for his essay on "Quadratic Complex Numbers." The essays of Mr. C. Godfrey, of Trinity, Mr. T. J. I. Bromwich, of St. John's, and Mr. B. Hopkinson, of Trinity, receive honourable mention.

Mr. A. Sedgwick, F.R.S., has been reappointed a Manager of the Balfour Fund for five years. The University table in the Marine Biological Laboratory at Plymouth is to be occupied by Mr. S. D. Scott, of King's; the corresponding tables at Naples are assigned to Mr. F. B. Stead, of King's, and Mr. K. R. Menon, of Christ's.

Prof. Lewis announces a course of lectures and demonstrations in Crystallography during the long vacation. Dr. Kanthack, Deputy Professor of Pathology, will give courses in Bacteriology, in Morbid Anatomy and Histology, and in Pathology.

The Examiners for the Mathematical Tripos announce that ninety men and twenty women "have acquitted themselves so as to deserve honours."

Honorary degrees will, on June 17, be conferred on the Archbishop of Canterbury, Lord Lansdowne, the Chief Justices of England and South Australia, a number of the colonial premiers—Sir George Goldie, Sir Arthur Arnold, Sir John Kirk, F.R.S., and Sir William H. White, F.R.S.

Dr. Percy Gardner, Lincoln Professor of Archæology at Oxford, Dr. Sydney H. Vines, F.R.S., Sherardian Professor of Botany at Oxford, and Dr. H. Marshall Ward, F.R.S., Professor of Botany at Cambridge, all of whom were formerly Fellows of Christ's, have been elected Honorary Fellows of the College.

THE following are among recent appointments:—Dr. J. L. Prevost to be full Professor of Physiology at Geneva; Dr. E. Kaufmann, Privat-docent in Anatomy at Breslau, to be Professor; Dr. K. Zeisig, Assistant Professor of Physics in the Darmstadt Technical High School, to be full Professor; Dr. Max Wolters, Privat-docent in Anatomy at Bonn, to be Professor; Dr. Ludwig Heim to be Assistant Professor of Hygiene and Bacteriology at Erlangen; Dr. M. Siegfried to be Assistant Professor of Physiological Chemistry at Leipzig; Prof. A. J. Moses to be Professor of Mineralogy, and Mr. H. M. Howe Professor of Metallurgy, in Columbia University; Mr. W. G. McMillan, Lecturer in Chemistry and Metallurgy at Mason College, Birmingham, to be Assistant Secretary of the Institution of Electrical Engineers.

THE name of the Michigan Mining School has just been legally changed to the Michigan College of Mines. It is proposed to make the tuition fees approximately the same as those charged by other advanced technical schools in America. When the school was working out its policy, it was thought wisest not to charge tuition, but to collect as wide a constituency as possible in order that there might be all possible chance to make the methods as broad and thorough as could be done. It was also deemed hardly just to the students to demand tuition until the institution was much better equipped for its work than the public assistance given during the first decade of its existence permitted. Now that success has been attained in educating men for practical work, the institution seems fully warranted in charging hereafter for its instruction. The new regulation comes into effect immediately after August 19.

A ROYAL charter, dated May 11, has, says the *Educational Times*, been granted for the establishment in Sheffield of a University College. The council of Firth College, the executive committee of the Sheffield Technical School, and the council of the Sheffield School of Medicine petitioned that those institutions should be consolidated and included in one college, having for its object the provision of such an education as might enable residents in the city and neighbourhood to qualify for degrees at any of the Universities in the United Kingdom. It was represented that the endowments of the institutions were of the aggregate value of 100,000*l*., and that there was reason to anticipate further contributions to a large amount after the incorporation of the College. The charter now granted sets forth, amongst other things, that the institution shall be known as

"The University College of Sheffield," and that women may participate in the benefits, emoluments, and government of the College to such an extent and in such a manner as the statutes of the College shall prescribe. There is to be no religious test for students, teachers, or other officers. The first president is the Duke of Norfolk, who is to hold office for five years, and be eligible for re-election. The first vice-presidents are Sir F. T. Mappin, Sir Henry Stephenson, Dr. H. C. Sorby, and Dr. Dyson.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"On a New Method of Determining the Vapour Pressures of Solutions." By E. B. H. Wade, B.A., Scholar and Coutts Trotter Student of Trinity College, Cambridge. Received April 26.

The statical methods, which have hitherto alone been capable of furnishing results between 60° C. and 100° C., have been attended with serious errors. The apparatus employed in this research was in conception similar to that of Sakurai, except that it was in duplicate, a divided steam supply passing through two U-tubes placed in parallel. It differed, however, from his apparatus in several important particulars, which cannot be adequately described in a brief notice.

Suffice it to say, that the pressure on the contents of the two U-tubes being the *same*, could be adjusted to any convenient value, and that the method of thermometry being the differential platinum one, the *difference* only of the boiling-points of pure water and salt solution, in their respective U-tubes, was recorded. Two series of observations were made at a pressure of 760 mm., in one of which a small external heat supply was used to compensate the condensation in the U-tubes, and a second in which it was found possible to dispense with it.

Neither method gives results differing systematically from the other, though the latter method was greatly preferred.

The substances examined were the chlorides of lithium, calcium, strontium, sodium, and potassium, and bromides of the two last named. A full discussion is here impossible, but we may notice that in all cases the ratio increase of boiling-point to concentration is of the same order as that calculated from Arrhenius' theory, but that the discrepancy always exceeds the experimental error, except in the case of potassium chloride, and is particularly great in the case of calcium chloride. The latter substance gave less well-defined boiling-points than the others which were investigated, for some reason as yet unknown, and the experimental error was here certainly at its greatest, but still not nearly enough to account for the difference.

May 14.—"An Attempt to cause Helium or Argon to pass through Red-hot Palladium, Platinum, or Iron." By William Ramsay, F.R.S., and Morris W. Travers. Received April 9.

A tube of hard, infusible glass was connected at one end with the reservoir of the gas under experiment, helium or argon. Into its other end was corked a tube of platinum, closed with a palladium cap, or, if iron was the metal under experiment, with a tube of thin wrought iron, also closed at the end; the closed end of the interior tube was placed so that it could be raised to a bright red heat by bringing a blow-pipe flame to bear on the hard glass tube. The open end of the metal tube was cemented to a glass tube, attached to a Töpler's pump, and provided with a Plücker's vacuum tube, so that the spectrum of any gas passing through the metal could be observed. This afforded, at the same time, a most delicate test of the presence of the gas under experiment. The metal tube was exhausted, until green phosphorescence appeared in the vacuum tube, and the gas, helium or argon, was admitted into the space between the glass and the metal tube, at atmospheric pressure. The glass tube was then heated to the highest temperature attainable with a blow-pipe—perhaps 900° or 950° C. In no case, whether the metal tube consisted of palladium, platinum, or iron, was there the smallest transpiration of gas, even after half an hour. The phosphorescent vacuum remained in all experiments quite unimpaired.

Physical Society, May 28.—Mr. Shelford Bidwell, President, in the chair.—Mr. Elder read a paper, communicated by Dr. Albert A. Gray, on the perception of the difference of phase by the two ears. The investigation relates to certain acoustical results obtained some years ago by Dr. S. P. Thompson; they may be summarised as follows: (*a*) When two simple tones in opposite phases are conveyed separately, through tubes or otherwise, to the two ears, the sensation of sound appears localised at the back of the head. (*b*) If the respective tones from two forks mistuned to give "beats" are conducted separately to the two ears, they still produce the sensation of "beats"; and, to the observer, this sensation also seems localised at the back of the head. The "beats" are distinct, but there are no true silences, at any rate so long as attention is fixed on the note. (*c*) Although "beats" are heard under these circumstances, no beat-tones are discernible by the binaural method. The author proceeds to explain the phenomena on the assumption that there is a physiological connection between the nerves of both ears. His evidence is derived from the following experiments: (*d*) A vibrating fork is held opposite one ear; the opposite ear is then closed by a finger; the sound of the fork now appears louder to the open ear. (*e*) If the fork is held opposite one ear, and the chain of ossicles of the second ear is then pressed gently inwards by a fine probe, the sound of the fork is heard with increased loudness by the first ear. (*f*) If the chain of ossicles in the second ear is dragged outwards by rarefaction of the air in the meatus, the above changes in loudness are no longer perceptible. The theory put forward by the author in explanation of these results is that they are due to reflex contractions of the tensor tympani or stapius (or more probably both) of the first ear. A further observation, of Pollak, is also brought to bear upon the question, *i.e.* (*g*) stimulation of one cochlea by sound causes contraction of the tensor tympani of both ears, and the contraction is permanent while the sound continues. This is known to be true for the lower animals, and is probably true for man. With regard to (*a*), the author observes that the muscular sense is there being appealed to in a manner quite new to it. The tympani are by nature trained each to relax or expand with the other, and they are thrown out of reckoning if the phases differ. Or, again, the stimuli from the two ears may collide at one of the lower nerve centres, and thus be annulled before any intimation has been received by the brain. The path taken by such stimuli is from the nucleus of one nerve, just after its entrance into the medulla, across to the corresponding nucleus of the opposite side. In these nuclei the stimuli from both ears mix. Some of the nerve-fibres have no nuclear intercommunication at the base of the brain; consequently, stimuli passing by these paths are not subject to interference. This agrees with (*b*), where the silences are not complete. (*h*) It is to be observed that beat-tones are sometimes perceived by the ear under circumstances where they cannot set a resonator into vibration. This indicates that beat-tones may be produced either in the ear or nerve-centres of the listener, and not exteriorly. (*i*) It has been shown by Dr. Thompson that when two simple tones, such as in ordinary hearing produce a differential tone, are led singly to the ears, no differential tone is heard. From this the author concludes that differential tones are not produced in the mind of the listener, nor in any of the cerebral centres. From (*h*) and (*i*) together, the point of production is restricted down to the ear itself; something of the sort was suggested by Helmholtz. Again, from (*g*), it appears that when two notes are sounded so as to give a differential tone, the tensor tympani must be in a state of continual contraction, for the intervals of silence are too short to permit of any relaxation. Meanwhile, there are certain periods during which the tympani membranes are not acted upon by any force external to the ear. The author is of opinion that if the movements of the ossicles upon one another were absolutely frictionless the membranes would come to rest in a position where the force of the contracting muscle was balanced simply by the tension of the membrane and the ligaments of the ossicles; but since the articulations of the ossicles have some friction, the equilibrium is otherwise, and he conjectures that the state of affairs is such that any force acting upon the hammer, tending to draw it inwards, produces a slight jerk, and this repeated gives the necessary impulses for the sensation of differential tones. The mechanics of this theory is not fully worked out.—Mr. J. Rose-Innes read a paper on the isothermals of isopentane. The author takes advantage of the recent experimental work of Ramsay and Young, upon the thermal properties of isopentane, to test a formula giving the relation of pressure to temperature for gases generally, over a considerable range of volume. From the linear equation, $p = bT - a$, for the pressure at constant volume, where a and b are functions of the volume, no formula could be found to give close agreement with observed results. More definite results are obtained by examining a quantity depending upon a and b together;

such a quantity is the temperature τ, at which, for each volume, the substance behaves as a perfect gas. It is shown by tables that τ is nearly a constant for volumes from 350 to about 8. Below volume 8 it diminishes very rapidly with volume. A further investigation refers to the $[(av^2)^{-1}; v^{-\frac{1}{3}}]$ curves of Young, for isopentane, and a corresponding formula. At volume 3·4 on this curve there is a decided peak, suggesting discontinuity. Ether gives a similar curve, and the question arises whether such curves would not be better represented by two or more equations. Prof. Young said the diagrams representing the observed and calculated isothermals were probably the best ever obtained. Divergence among the values of τ was explained in part by the smallness of the angle between the theoretical isochor for a perfect gas, and the real isochor. The point of coincidence was difficult to define. Moreover, the values of τ were obtained from "unsmoothed" values of v. The evidence against the linear law consisted in a certain similarity in the shape of the different curves. It was not easy to see where experimental errors could come in. The peak was a very striking feature of the curves, and the agreement between the results with ether and those of isopentane was very remarkable. These two substances had their boiling-points close together, their critical temperatures close together, and their molecular weights nearly alike. The two substances not only agreed in each giving a peaked curve, but the peak corresponded to almost identical volumes. Prof. Young hoped at some future time to examine normal pentane, and to determine whether τ was a constant for this substance also.—The President proposed a vote of thanks to the authors of the papers, and the meeting was adjourned until June 11.

CAMBRIDGE.

Philosophical Society, April 26.—Mr. F. Darwin, President, in the chair.—On the apparent electrification in an electric field at the bounding surface of two dielectrics, by Prof. A. Anderson.—On luminosity attending the compression of certain rarefied gases, by Mr. H. F. Newall. This paper contains a description of the circumstances under which phosphorescence has been observed by the author when certain rarefied gases (initially at a pressure of about 0·01 mm. to 0·05 mm.) are compressed into a volume about one-twentieth of the initial volume. The explanation of the phosphorescence in the case when oxygen is the gas used appears to be in agreement with the explanation given by Sutherland (*Phil. Mag.*, March 1897), of anomalies observed by Bohr and Crookes in the compression and rarefaction of this gas. According to Sutherland, in the rarefaction of oxygen a point is reached (pressure 0·7 mm.) when oxygen begins to be converted into ozone, and below the pressure 0·15 mm. the gas is entirely ozone. Between the pressures 15 mm. and 0·7 mm. the gas obeys Boyle's law as oxygen, and below 0·15 mm. it obeys Boyle's law as ozone. Between the pressures 0·7 mm. and 0·15 mm. the gas is a mixture of oxygen and ozone. Sutherland is led to the view that in the compression of ozone from the lowest pressures, the ozone begins, when the pressure reaches the value 0·15 mm., to be knocked to pieces in virtue of the frequency of collision between ozone molecules being the same as that of some natural vibration in the molecule. It appears that in the phosphorescence observed by the author as arising during compression of the rarefied gas from a pressure of about 0·02 mm. to pressures lying between 0·3 mm. and 0·5 mm., the ozone is converted into oxygen, and the energy evolved is regarded as resulting in phosphorescence. It is not clear, however, what part is played in the phenomena by the impurities, but it seems certain that their presence is of importance, if not essential for the production of the phosphorescence. The spectrum emitted by the phosphorescent gas is very striking, and consists of four bright bands, coinciding with those which Schuster has described as belonging to the spectrum of the negative glow of oxygen. When the same mixture of gas is at a highe ıpressure, it is possible to produce in it a bright phosphorescence by passing a momentary electrical discharge through it by Prof. J. J. Thomson's method. The phosphorescence is faint at a pressure of 0·6 mm., is at a maximum about 0·4 mm., and is not visible at a pressure below 0·1 mm. (These pressures vary with the impurities present in the mixture.) In the electrical production of phosphorescence in oxygen, it would appear (1) that the gas was initially mainly oxygen, (2) that the momentary discharge supplied it quickly with energy and converted it into ozone, and (3) that the ozone slowly reverted again to oxygen with phosphorescence. In this case, however, the spectrum exhibits no bright lines or bands, but is simply continuous. The author offers no explanation of the difference in the spectra in the two cases of phosphorescence, but calls attention to the probable importance of the observation in connection with astronomical matters and, in particular, with the luminosity of extended nebulæ.

PARIS.

Academy of Sciences, May 24.—M. A. Chatin in the chair.—Tools and weapons of the Copper Age in Egypt: methods and manufacture. New researches, by M. Berthelot. The objects described belong to most ancient Egyptian times, and consist of practically pure copper, no tin being present in any case. A careful examination of some copper needles, found in a tomb at Abydos by M. Amelineau, showed that they had been prepared from a thin lamina of metal, by folding over and subsequent forging. A small chisel obtained from the same place was found to have been made in a very similar manner. A hollow needle was formed from thin copper leaf, in a manner very similar to that employed at the present time in the manufacture of helical tubing for bicycles.—On some liquids contained in antique vases, by M. Berthelot. A liquid found in a flask near Rheims, probably dating from Roman times, showed that the flask originally contained a fat, into which, the flask being open, water filtered in.—Action on light upon gas mixtures, in case where it causes combination, especially on mixtures of hydrogen and chlorine, by MM. Armand Gautier and H. Hélier. No hydrochloric acid is produced from a mixture in equal volumes of hydrogen and chlorine if the latter are prepared and kept in the dark. This is the case even after prolonged exposure, one experiment extending over fifteen months. Similar results were obtained if the mixture was submitted to a very feeble illumination, such as a candle.—New study of tempests and tornadoes, by M. H. Faye. Remarks by the author on the presentation of his work to the Academy.—On the stay of General Poncelet at Saratow, by M. Germain Bapst.—New improvement of the grisometer, by M. N. Gréhant. The instrument is placed in a jacket with parallel glass sides, through which water is kept running.—The surface of cast-iron, kept at a red heat, is able to transform carbonic acid into carbon monoxide, by M. N. Gréhant.—On the elastic vibration and resistance of cannon, by MM. F. Gossot and R. Liouville.—Scientific mixtures, by M. Constant Dubois.—Remarks by M. Mascart on a catalogue of meteorological observations made in France since 1850, taken from the *Annales du Bureau central météorologique.*—On some doubts cast upon the laws of Colonel Goulier relating to the variations of length of levelling sights, by M. Ch. Lallemand. The observations cited, which are mostly produced graphically as curves, all go to confirm the accuracy of the conclusions drawn by Goulier.—On the reflection of light by a long and narrow surface, by M. Gouy. Some remarks on a paper by MM. Nichols and Rubens.—On a phosphorescent anti-anodic system, and the anode rays, by M. C. Maltézos.—On the properties of certain parts of the spectrum, by M. Gustave Le Bon. A reply to the criticisms of M. Becquerel concerning the transparency of ebonite for rays of low refrangibility.—On the precipitation of zinc sulphide in the estimation of this metal, by M. J. Meunier. The difficulties observed in the precipitation of zinc as sulphide are caused by the presence of a large excess of ammonium sulphide; they disappear if only just sufficient hydrogen sulphide is present to cause the complete precipitation of the zinc.—Remarks relating to the heat of formation of the sodium derivatives of acetylene, by M. de Forcrand. Taking into account the latent heat of fusion of acetylene, the latter being deduced from observations by Villard on the heat of formation of the hydrate $C_2H_2 + 6H_2O$, the amounts of heat developed by the successive replacements of the two hydrogen atoms in acetylene by sodium are very nearly equal, the formation of C_2HNa giving out a slightly greater amount (2 Cal.) than that of C_2Na_2.—Some new combinations of pyridine, quinoline, and piperidine with metallic salts, by M. Raoul Varet. — On the preparation of furfurane, by M. P. Freundler. The dry distillation of barium pyromucate gives a poor yield of furfurane, owing to the formation of gaseous products in a secondary reaction; but a quantitative yield is obtained on heating pyromucic acid in small quantities in sealed tubes at 260° to 275°, five grams of the acid giving in this way more furfurane than is obtained by the dry

distillation of one hundred grams of the barium salt.—Solubility of ecgonine, by M. Œchsner de Coninck. The solubility of ecgonine is given for twenty-five organic solvents.—Comparative study of the changes in the respiratory quotients of fruits during ripening, by M. C. Gerber.—On the denaturation of alcohol, by M. Ernest Barillot. It is shown that the method of Dr. Lang employed in Switzerland for the denaturation of alcohol is of little use, since a simple treatment with a bisulphite, followed by a fractional distillation, is sufficient to recover 70 per cent. of the alcohol in a pure state.—On the embryonic shell of the Lamellibranchs, by M. Félix Bernard.—Disease of the branches of the mulberry in Turkey, by MM. Prillieux and Delacroix. The disease is caused by the attack of a parasite, *Sclerotinia libertiana*.—The subterranean hydrography of the Devoluy, by M. E. A. Martel.—Trophic troubles following the section of the posterior medullary roots, by M. J. P. Morat.—Influence of the stretching weight upon the heat disengaged by muscle during contraction, by Mlle. M. Pompilian.—On the antiquity of tatooing as a mode of treatment, by M. Fouquet.—Medico-legal appreciation of traumatic lesions and determination of individual identity by the X-rays, by M. Foveau de Courmelles.—On the three French balloon ascents and the third international experiment, by MM. Hermite and Besançon.—On the formation of acetic acid in a gas battery, by M. Gaudet.—On a means of stopping a leak from the outside of a ship, by M. Burgal.

DIARY OF SOCIETIES.

THURSDAY, June 3.

Royal Society, at 4.—Election of Fellows.—At 4.30.—The Sensitiveness of the Retina to Light and Colour: Captain Abney, F.R.S.—On the Mechanism by which the First Sound of the Heart is produced: Sir R. Quain, F.R.S.—Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races: Miss Alice Lee and Prof. K. Pearson, F.R.S.—An Investigation on the Variability of the Human Skeleton, with especial reference to the Naquada Race, discovered by Prof. Flinders Petrie in his Explorations in Egypt: E. Warren.—On the Brains of Two Sub-Fossil Malagasy Lemuroids: C. I. Forsyth Major.—(1) On the Dielectric Constants of certain Frozen Electrolytes, at and above the Temperature of Liquid Air; (2) On the Dielectric Constants of Pure Ice, Glycerine, Nitrobenzol, and Ethylene Dibromide, at and above the Temperature of Liquid Air: Prof. Fleming, F.R.S., and Prof. Dewar, F.R.S.—Preliminary Communication on the Nature of the Contagium of Rinderpest: A. Edington.

Linnean Society, at 8.—Observations on Termites: Dr. G. D. Haviland.—On the Genus Ramulina: Prof. T. Rupert Jones, F.R.S., and F. Chapman.

Chemical Society, at 8.—On the Thermo-chemistry of Carbohydrate Hydrolysis; On the Thermal Phenomena attending the Change in Rotatory Power of Freshly-prepared Solution of certain Carbohydrates, with some Remarks on the Cause of Multirotation: Horace J. Brown, F.R.S., and Spencer Pickering, F.R.S.—Optical Inversion of Camphor; Derivatives of Camphoric Acid. Part II. Optically Inactive Derivatives; Racemism and Pseudo-racemism: Dr. F. S. Kipping and W. J. Pope.—On some New Gold Salts of the Solanaceous Alkaloids: Dr. H. A. D. Jowett.

FRIDAY, June 4.

Royal Institution, at 9.—Signalling through Space without Wires: W. H. Preece, C.B., F.R.S.

Geologists' Association, at 8.—The Origin of the High-Level Gravel with Triassic Débris adjoining the Valley of the Upper Thames: H. J. Osborne White.

SATURDAY, June 5.

Geologists' Association—Excursion to Cheltenham and Stroud. Leave Paddington at 10.32 a.m.

TUESDAY, June 8.

Royal Institution, at 3.—The Heart and its Work: Dr. E. H. Starling.

Anthropological Institute, at 8.30.—Newly-discovered Stone Implements from Somaliland, and from the Lost Flint Mines of Egypt: H. W. Seton-Karr.—Anthropology in Brittany: Dr. Topinard.—Physical Anthropology of the Isle of Man: A. W. Moore and Dr. John Beddoe, F.R.S.—*Probable* Papers: The Walloongurra Ceremony: R. H. Mathews.—Prehistoric Diamond Fields: W. H. Penning.—The Capping Ceremony in Korea: Dr. E. B. Landis.

Royal Photographic Society, at 8.—Photographic Surveys: C. J. Fowler.

WEDNESDAY, June 9.

Geological Society, at 8.

THURSDAY, June 10.

Mathematical Society, at 8.—Models of the Regular Convex and Star Solids: W. W. Taylor.—The Calculus of Equivalent Statements (Sixth Paper): H. MacColl.

FRIDAY, June 11.

Royal Institution, at 9.—Diamonds: W. Crookes, F.R.S.

Royal Astronomical Society, at 8.

Physical Society, at 5.—The Effect of Sea-water on Induction Telegraphy: C. S. Whitehead.—A New Definition of Focal Length, and an Instrument for its Determination: Thomas H. Blakesley.—On the Decomposition of Silver Salts under Pressure: Dr. J. E. Myers and Dr. F. Braun.—On a New Way of determining Hysteresis in Straight Strips: Dr. Fleming, F.R.S.

Malacological Society, at 8.

SATURDAY, June 12.

Royal Botanic Society, at 4.

London Geological Field Class.—Excursion—Coulsdon to Merstham. Lower Chalk. Leave Cannon Street, 2.17; arrive Coulsdon, 2.59.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Books.—The Induction Coil in Practical Work: Lewis Wright (Macmillan).—Report on the Working and Results of the Woburn Experimental Fruit Farm since its Establishment: the Duke of Bedford and S. U. Pickering (Eyre).—An Essay on the Foundations of Geometry: B. A. W. Russell (Cambridge University Press).—Hypnotism and its Application to Practical Medicine: Dr. O. G. Wetterstrand, translated by Dr. H. G. Petersen (Putnam).—Abel's Theorem and the Allied Theory, including the Theory of the Theta Functions: H. F. Baker (Cambridge University Press).—A Manual of Botany: Prof. J. R. Green, Vol. 1, new edition (Churchill).—Illustrative Cloud Forms: Captain C. D. Sigsbee (Washington).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 4 (Edinburgh, Douglas).—Lessons in Elementary Practical Physics. Vol. 3, Part 1. Practical Acoustics: C. L. Barnes (Macmillan).—Einführung in der Theorie der Analytischen Functionen einer Complexen Veränderlichen: Prof. H Burkhardt (Leipzig, Veit).—Africa, Antropologia della Stirpe Camitica: G. Sergi (Torino, F. Bocca).—Twelve Charts of the Tidal Streams near the Channel Islands and neighbouring French Coast: F. H. Collins (Potter).—Cours Supérieur de Manipulations de Physique: Prof A. Witz, deux édition (Paris, Gauthier-Villars).—Guide to the Genera and Classification of the North American Orthoptera found North of Mexico: S. H. Scudder (Cambridge, Mass., Wheeler).—Telepathy and the Sublimal Self: Dr. R. O. Mason (K. Paul).—Electric Movement in Air and Water, with Theoretical Inferences: Lord Armstrong (Smith, Elder).—The Outlines of Physics: Prof. E. L. Nichols (Macmillan).—Formation de la Nation Française: Prof. G. de Mortillet (Paris, Alcan).

Pamphlets.—Längenänderung und Magnetisirung von Eisen und Stahl: G. Klingenberg (Berlin, Simion).—Ueber den Gebrauch der von Prof. E. v. Federow, herausgegeben Stereographischen Netze (Leipzig, Engelmann).—Homogene Structuren: Barlow (Leipzig, Engelmann).

Serials.—Botanische Jahrbücher, &c., Vierundzwanzigster Band, 1 Heft (Leipzig, Engelmann).—Proceedings of the Royal Society, Edinburgh, Session 1896–97, Vol. xxi. No. 4, pp. 249–312 (Edinburgh).—Humanitarian, June (Hutchinson).—Natural Science, June (Page).—Chambers's Journal, June (Chambers).—Contemporary Review, June (Isbister).—National Review, June (Arnold).—Century Magazine, June (Macmillan).—Astrophysical Journal, May (Chicago).—Notes from the Leyden Museum, Vol. xviii. Nos. 2, 3, 4 (Leiden).—Scribner's Magazine, June (S. Low).

CONTENTS.

THURSDAY, JUNE 10, 1897.

PLANT PATHOLOGY.

Diseases of Plants induced by Cryptogamic Parasites. By Dr. Karl Freiherr von Tubeuf. English Edition, by William G. Smith, B.Sc., Ph.D. Pp. xv + 598. (London: Longmans, 1897.)

WHEN the German edition of this work appeared, early in 1894, it at once took rank as one of the most comprehensive and accurate treatises on the subject that had as yet appeared, and the English edition we now have to welcome still deserves this tribute to its merits, for the author has taken the opportunity of adding considerably to the already bulky volume.

The fungus-diseases of plants now number so many forms, that no apology is necessary for treating them separately from the very numerous other diseases of plants; but it should be clearly borne in mind that only part of the very wide subject of the pathology of plants comes under this head, as may be readily seen on comparing the new edition of Frank's "Krankheiten der Pflanzen," which has appeared in the interval, and of which the first volume is devoted to the diseases due to non-living agents, the second to those caused by parasitic plants (not fungi only), and the third to pathological states induced by animals.

Thus comprehensive works on the whole range of this vast subject are not wanting, and the student should observe that the standpoint from which a treatise like this is written differs considerably from those assumed by writers on the general subject of pathology, or those who deal with the morphology and physiology of the fungi.

Berkeley, Frank, Sorauer, and Hartig have shown that the diseases of plants constitute a theme by itself which may be treated with reference either to the symptoms and progress of the pathological conditions, where the victim of disease furnishes the principal phenomena discussed, or to the causes or agents which induce these pathological conditions. These agents may be internal or external, and the latter comprise factors of the non-living environment, or living organisms—animals or plants in anti-biotic relations to the host, or victim.

The present large volume, of more than 600 pages with 330 illustrations, is devoted, as said, to the narrower theme, and bears witness to the astonishing progress made in the study of the parasitic fungi during the last quarter of a century.

Its subject-matter is principally the fungi themselves, and in character it partakes of the nature of a flora or diagnostic list, and a treatise on symptoms and therapeutics, with bibliographical references for those who wish to launch further into this particular arm of the sea of knowledge. It is thus neither a complete treatise on the biology of fungi, nor a detailed work on pathology, but—and in this reside its peculiar characteristics—a volume compiled to meet the wants of an increasing class of students who wish to know something of the parasitic fungi themselves and what plants they attack; something of the mode of attack and the symptoms induced; and something of the suggestions for combating the diseases which have been supplied by experiments in the field. It is thus a typical example of a class of book evolved under the stimulus of the practical spirit of the age, and, in fairness to all be it said, of a high standard of excellence as scientific literature; further, it will be of no use to the crammer, to the examinee, or the dilettante, but must take its place on the shelf of the serious worker, the true naturalist, and the educated cultivator of plants as an indispensable work of reference.

The book consists of two parts, of which the first contains chapters on the nature of parasites and parasitism, the reactions between host and parasite, infection, predisposition, preventive measures, and the economic importance of the diseases of plants, together with a short summary of the facts of symbiosis.

The second, and far larger part, is devoted to a systematic account of cryptogamic parasites—the fungi proper, slime-fungi, bacteria and pathogenic algæ being included. The system followed is that of Brefeld, the saprophytic forms being omitted.

Objection may be made to the inclusion of the algæ and symbiotic forms, such as mycorhiza, the organisms of the leguminous nodules, lichens, &c.; but Tubeuf has something of his own to say about these matters, and although I do not agree with his strained attempts to classify the phenomena of saprophytism, parasitism, and symbiosis, and regard his selection and definition of the terms *nutricism* and *individualism* as particularly unfortunate and misleading, I think that he was quite right in discussing these matters here, if only to help in emphasising the real nature of parasitism by contrast.

The author has avoided several pitfalls. It would have been easy to give way to temptations to discuss in detail several disputed points, especially as Tubeuf is himself an investigator with strong views of his own; but it is noticeable throughout that he attempts a fair summary of the published accounts. The fault of over-description has also been wisely and ably avoided, and this, on the whole, without sacrifice of usefulness; though it must be borne in mind that a good deal of preliminary acquaintance with the subject is necessarily demanded from the reader. Again, there is sufficient treatment of theoretical matters to make the book attractive to botanists not specially concerned with pathology in detail, and, further, the hints on practical therapeutics, though necessarily short, appeal to the cultivator himself, and show that the book is designed to help him.

One fault of omission must be mentioned, if only in justice to those who have done good work in this country: the English literature is almost wholly ignored. We hesitate whether to blame the author—who only follows the too common practice of continental writers—or the editor for this. In any case the latter might have included references to Massee's and Somerville's experiments with *Plasmodiophora*, in his notes, to say nothing of other work by English botanists.

A feature in the work, which adds immensely to its value, is the selection of photographic illustrations of the diseased plants themselves, showing how the victims of fungus attacks look. This is as near an approach to taking the student into the field and showing him the disease at work, as can possibly be made in a book; and when we reflect that this—so to term it—clinical study is as important for plant diseases as it is in the case of human diseases, its importance is obvious. Few people are aware how

much there is to be seen and learnt in the natural history of the diseases of forest and field and garden plants, and Tubeuf's examples should stimulate botanists to pay more attention to the subject. It is true the reproductions of the photographs are by means of the detestible "process blocks," which disfigure most of the books of the present age; but I suppose we must agree that the choice lies between these or none, as prices and means go.

It will be evident that the book is too large for even a brief review of more than the principal headings, but there are one or two features of importance which stand forth in salient contrast to anything met with in similar works.

These are signs of the times. One of the most striking is the far too meagre note on "selection of hardy varieties"—the word "hardy" does not accurately translate the original. From all sides we are now hearing that different varieties of vines, potatoes, wheat, &c., show different disease-resisting powers, and Tubeuf says, "An important method for the protection of plants from disease . . . consists in the selection and cultivation of varieties and species of plants able to resist the attacks of parasitic fungi."

The very brief account of what has been done with the vine, and the reference to what has been discovered about wheat, will only leave the reader hungry for more information.

In Eriksson and Henning's exhaustive volume on wheat-rust—to which I can discover no reference here, the author confining his remarks to a note they published last year in the *Zeitschrift f. Pflanzenkrankheiten*—the student will find that as matter of fact some varieties of wheat suffer little, and others much from *Puccinia*; and their extended investigations show that no mechanical theory as yet proposed explains this, but that a complex physiological phenomenon is here before us. They also show that the *Puccinia* of wheat-rust also varies, both morphologically and in its physiological relations to the disease. We have, in short, to face the fact that the culture of wheat-rust (for we do cultivate it), as well as the culture of cereals, result in the variation of both fungus and cereal, and it appears that selected varieties of both arise and are propagated.

Such varieties of parasitic fungi are also known in other groups—*e.g. Peridermium*, *Gymnosporangium*, *Ustilago*, &c.—and Tubeuf gives a short note under the respective heads; and we have several indications that physiological races are as common among parasitic fungi as they are among bacteria.

Clearly it is matter for experimental inquiry how far these variations are independent or concomitant, and it may be considered that one of the strongest reasons for encouraging the carrying out of agricultural experiments on a large scale, and the gathering of statistical results, that scientific men can urge, is the hope that more light will be thrown on the relations of these variations, and that we may succeed in utilising the knowledge in the practical evasion of disease. I remember being strongly impressed, in 1880–81, by the varietal differences between the *Hemileia* on coffee and that on *Canthium* in Ceylon, and even then threw out the hint that the former had been derived from the latter; but the comparative immunity of *Coffea Liberica* as contrasted with *C. Arabica*, suggested that it was not impossible that a disease-resisting coffee should be found.

The subject is complex, and bristles with difficulties; but that is no reason for hesitating as to the experimental inquiry; and indeed it has already been commenced in several countries, as the reports from Australia, America and elsewhere show.

Another feature of interest and importance in Von Tubeuf's book, is the chapter on "preventive and combative measures," involving the treatment of diseased plants by means of chemicals. Here, again, I notice a lack of attention to the English literature: Berkeley, and others of our countrymen, had experimented with sulphur in various forms, long before most of the authorities mentioned had taken the matter up. Still, it is quite true, the introduction of Bordeaux-mixture, and its employment on the enormous scales adopted in France, Australia, America and elsewhere, have taught us much, and suggested more. It is a common mistake to suppose that the intelligent application of remedial measures to plant-diseases does not pay—there are plenty of witnesses to the contrary; but, unfortunately, school and university courses generally have allowed of so little attention to the knowledge that must be utilised in carrying out such measures, that even skilled farmers, foresters, and other cultivators of plants, have to enter upon these experiments quite unequipped for carrying them out properly.

Tubeuf's chapter on the "economic importance of diseases of plants" may be cordially—if sadly—recommended to all who are interested in the very necessary extension of technical education by the institution of agricultural schools and colleges. He quotes the losses due to the Californian vine-disease (1892) at 10,000,000 dollars; in 1891 the wheat-rust cost Prussia over 20,000,000*l*., and Australia something like 2,500,000*l*. Even allowing for large exaggerations—though reports from Sweden, India, Ceylon, the West Indies, and elsewhere suggest similarly large losses from fungus epidemics—in these estimates, it is evident that we have here to deal with annual losses of which even a saving of a very few pounds *per cent.* would be worth consideration; and the comparatively meagre experiments to hand hold out hopes of much more considerable saving, if steps are taken in time, with a due and intelligent knowledge of the problems to be faced, and the methods of facing them.

This must suffice for our review of this excellent book, the technical details of which are well treated, of the highest importance, and abounding with interest to the naturalist and botanist, as well as to the technologist and practical cultivator. H. MARSHALL WARD.

CAPTAIN LYONS' REPORT ON THE ISLAND OF PHILÆ.

A Report on the Island and Temples of Philæ. By Captain H. G. Lyons, R.E.; with an Introductory Note by W. E. Garstin, C.M.G. (Printed by order of H.E. Hussein Fakhri Pasha, Minister of Public Works in Egypt, 1897.)

THE proposal to build a dam at Philæ, which was brought before the Egyptian Government a few years ago, at the instance of Mr. Willcocks, of the Irrigation Department of Egypt, will be fresh in the memory of many of our readers, even though the details of the

somewhat acrimonious discussion upon it which followed in the papers have been forgotten. Briefly, the Egyptian Government had been informed by its English advisers that a better regulated and larger supply of water was needed for agricultural purposes in that part of the valley of the Nile which lies between Aswân and the Mediterranean Sea, and steps were at once taken to find out how that supply could be secured. Mr. Willcocks was ordered to seek out a site where a huge dam could be built for the purpose of holding back the water behind it; and after much thought and careful examination of the various possible sites, he decided that the best place was at Aswân, a few miles to the north of the beautiful little island of Philæ. The announcement of this decision was received with astonishment and outcries, for it needed no expert knowledge to see that the carrying out of the scheme meant, practically, the destruction of the monuments upon the island, and the submerging of both it and the greater part of the buildings upon it for a considerable number of weeks each year. When Mr. Willcocks' scheme was put before the public in its entirety, it was seen that he had indeed contemplated this disastrous result with calmness, and that if his superior officers accepted his report, one of the most picturesque spots in Egypt would be turned into a huge reservoir. Thereupon followed vigorous protests in England and other civilised countries, and at length the characteristic English compromise was proposed. As was to be expected, the usual nonsense was talked and written by the irresponsible person and faddist, and even archæologists signed their names cheerfully at the foot of columns of vehement protests filled with loose statements and inaccuracies. There is no blinking the fact that an attempt was being made to destroy a unique and very lovely bit of scenery, but it must at the same time be remembered that the actual needs of an agricultural population of a country have to be considered, even at the expense of the gratification of the æsthetic sentiments of visitors from other countries. Fortunately, when the dispute was hottest, certain irrigation experts discovered that all practical advantages necessary would be secured to the Egyptian farmer if the height of the water in the proposed reservoir was less than that suggested by Mr. Willcocks, and Mr. Garstin was able to modify the scheme in such a way as to reduce it by about twenty-seven feet. So that if the reservoir is ever built, Mr. Garstin promises us that "the greater portion of the ruins on the island will remain permanently above the submerged level."

Having agreed to adopt a modified scheme for the building of the dam and for the formation of the reservoir, it next became the duty of the Egyptian Government to take steps to see that the monuments *in situ* were not destroyed by the water in which their lower courses must stand, and, as a result, it ordered that the foundations of these structures should be examined and reported upon. To carry out this important work Captain H. G. Lyons was appointed, and the handsome volume before us contains the results of his labours at Philæ during the last two or three years. Without going into details, it must suffice here to say that he has carried out his work conscientiously, and that every person who has ever seen Philæ will accord him his heartiest thanks for the splendid series of photographs and plans of the island which accompany his report. But however interesting these may be, they are relatively of small importance beside the facts concerning the foundations of the buildings on the island which he now makes known to the world, and we feel sure that the minds of many will be much relieved thereby. It has long been known that the architects of ancient Egypt gave their finest buildings but shallow foundations; but that this was not universally the case is proved by the Temple of Isis at Philæ, in which the foundations of the main buildings descend to the bed rock, and many will be surprised to learn that there is as great a depth of masonry below the ground surface as there is height above it.

"Even in the case of the great pylon," Mr. Garstin says, "the depth of the foundation is some five metres; so that the masonry already descends below the level permanently saturated by infiltration, and consequently the conditions of equilibrium of the structure will be unchanged, even should the water-level be very considerably raised."

Along with the examination of foundations, Captain Lyons has effected a considerable number of important repairs, which have been unostentatiously carried out; and if the other measures which he recommends be adopted, it seems probable that little or no danger to the temples will exist, even should the water yearly rise and fall around their bases. This is Mr. Garstin's view of the matter, and, after all, he is the responsible person ultimately. Briefly, if the reservoir be made, much of the quay wall will have to be rebuilt, and the underground spaces between the cross-walls, which support the pavement of the west colonnade, and the crypts of the great Temple of Isis will have to be filled up with rough masonry. The picturesque remains of the Coptic village, at Philæ, must, of course, disappear, because the mud-brick walls will not withstand the action of the water; but archæologists have long ceased to expect to find there any Coptic antiquities of importance, and consequently will not grieve overmuch. Satisfactory as Captain Lyons' report is in all respects, we cannot help feeling that Egyptologists will be disappointed at one result—that is, his failure to find the remains of any building older than the time of Nectanebus, the last native king of Egypt, about B.C. 360. This is, of course, not his fault, but one of the early investigators of Egyptian antiquities, mentioned by Lepsius in his "Letters from Egypt" (London, 1853, p. 525), expressly states that the remains of much earlier buildings were found built into the structures of the Ptolemaïc period. That the Egyptians, before the time of Nectanebus, made no use of the island of Philæ, it is impossible to believe, especially as they built edifices upon the neighbouring island of Biggeh. So far back as B.C. 3500 we know that Egyptian officials passed that way on their road south to bring back pygmies for the royal court at Memphis, and all the gifts and tribute from the south must have been carried into Egypt by that way. In the time of the twelfth dynasty, about B.C. 2500, a body of lightly-armed "runners" was attached to the garrison at Aswân, whose duty it was to guard the cataract, and it is hard to think that Philæ did not form a base for operations at this period. About one thousand years

later a temple of Osiris seems to have stood on the island, for a governor of Nubia, called Merimes, cut his name, which is found, along with those of his predecessors and successors, in remembrance of a visit thereto, on rocks on the island of Biggeh (see Brugsch, "Egypt," i. p. 423). In the reign of Rameses II., the builder of the temples at Kalabsheh and Abû Simbel, no mention is made of Philæ, and, curiously enough, no remains inscribed with his prænomen and nomen have been found there. The probable explanation of the silence of the monuments about Philæ is that the island was usually reckoned as a part of Biggeh, and even the Greeks and Romans included both islands in the name of Philæ. Be this as it may, we believe that a temple, or temples, existed at Philæ from the earliest period, and that their remains were removed entirely by those who set up the buildings for Nectanebus and his successors; for, after Captain Lyons' exhaustive survey, it is impossible that any can be found there.

It is now our pleasant duty to call the reader's attention to the series of sixty-seven plates which illustrate Captain Lyons' report, and to fully endorse Mr. Garstin's statement that if the ruins of Philæ were to "disappear to-morrow, the scientific world would still possess a record of each detail of their outline and construction," and we rejoice to hear the promised survey of Nubia has been already begun. Though every intelligent person would view with indignation the slightest damage done unnecessarily to the temples at Philæ, still it must be admitted that antiquarian sentiment should not stand in the way of the prosperity of the country of Egypt. If the scheme of a reservoir at Aswân produces a complete survey of the country for two hundred miles south of it, we may hope that a scheme for a reservoir at Gebel Silsileh will be followed by a complete survey of the country to the north of it. Finally, we congratulate Mr. Garstin and Captain Lyons on the completion of a delicate piece of work, and thank H.E. Hussein Fakhri Pasha for sending forth to the world the results in such a sumptuous form.

ASSAYING IN WORKS LABORATORIES.

Notes on Assaying. By P. de P. Ricketts, E.M., Ph.D., Professor of Analytical Chemistry and Assaying, School of Mines, Columbia University; and E. H. Miller, A.M., Ph.D. of Columbia University. Pp. viii + 311. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1897.)

Recueil de Procédés de dosage pour l'analyse des combustibles, des minerais de fer, des fontes des aciers et des fers. Par G. Arth, Professeur de Chimie Industrielle à la faculté des Sciences de Nancy. Pp. iii + 313. (Paris: G. Carré et C. Naud, 1897.)

THE reissue in a new and enlarged form of Prof. Ricketts' well-known book will be welcomed by all who have used the former editions. As Dr. Miller now assists his chief, the book appears as a new one. It is intended to be used in the laboratories of works where only notes for reference are required, and long and detailed descriptions of well-known operations are unnecessary. The result is that it is written in a crisp and telegraphic style, which should commend itself not only to Americans, but to all busy assayers. On the other hand, students would often require a little supplementary oral teaching to enable them to perform the operations efficiently.

The first part, comprising an account of apparatus, reagents and methods, is good of its kind, although there is little that is new. Regarding litharge, there is a noticeable statement that "it should be free from red oxide of lead, as the latter has the power of oxidising silver and thus causing loss of that metal during the assay." This property, however, is shared by litharge; and it would be interesting if experiments were made showing the relative losses due to the action of the two reagents.

In the part dealing with the fire assays of ores and of bullion, the most interesting sections are those on the assay of gold and silver. The method given of parting the beads from gold ores, by heating them with acid in porcelain crucibles, is seldom used in this country, though it is in general use in America and Australia Its merits are little understood in Great Britain, where it is often adversely criticised. It would appear that no adequate defence of it has yet appeared in print, though it would not be difficult to furnish one. Space forbids any attempt of the kind here. It is sufficient to observe that objections to it have been raised mainly by those who have never tried it, and who do not know how easy it is to obtain exact results by its aid.

The method of assay of gold bullion is described as being that used at the Royal Mint, London, where, the authors imply, the greatest accuracy is obtained. Besides the assay of all metals usually found in ores, an account of qualitative blow-pipe analysis is given, and the whole book is far more complete in its present form than was the case with the previous issues.

M. Arth's book is also one of considerable merit. It is an account of the exact methods of analysis used in iron and steel works in France, and will be useful to the works analyst in all countries. It distinguishes between two kinds of analyses: the one required as a daily control of the works, the other to serve as a basis for experiments or in delicate researches. The rough and ready methods employed for the former purpose are, of course, unsuitable for the latter, and *vice versâ.* Both kinds are described, but the first-named class is undoubtedly the more efficiently treated, the Kjeldahl method for the estimation of nitrogen in fuel being, for example, fully described, and Dumas' method deliberately omitted except by name.

The methods of analysis used in steel works in France do not appear to differ materially from those used in this country, and some which are described were even devised on this side of the Channel. It is evident, therefore, that this book will prove as useful to our analysts as to their colleagues in France.

OUR BOOK SHELF.

Life and Letters of William Barton Rogers. Edited by his Wife, with the assistance of William T. Sedgwick. Vol. i. pp. viii + 427. Vol. ii. pp. vi + 451. (Boston and New York: Houghton, Mifflin, and Co., 1896.)

A TRULY great achievement of the life of William Barton Rogers was the foundation and establishment of the Massachusetts Institute of Technology, which ranks among the best technological schools in the world. His scheme was adopted by a general committee in October 1860, and

it became the basis of the present Institute. If Mr. Rogers had accomplished no more than this, he would yet have done a great service to the cause of science and education. He was, however, an active investigator, and the two volumes before us testify to the keenness of his interest in all scientific subjects.

William Rogers was born in 1804. He became professor of natural philosophy and chemistry at William and Mary College, Williamsburg, Virginia, in 1828, and professor of natural philosophy in the University of Virginia, and director of the geological survey of Virginia, in 1835. He resigned his professorship in 1853, and removed to Boston, where, a few years later, he took the chief part in founding and organising the Massachusetts Institute of Technology. The physical laboratory of the Institute was afterwards given the designation of "The Rogers Laboratory of Physics," in recognition of his services to physical science and devotion to the interests of the Institute. Mr. Rogers was president of the American Association for the Advancement of Science in 1876, and succeeded Prof. Henry as president of the National Academy of Sciences in 1879. He died suddenly in May 1882, while delivering a short address to the students of the Institute of which he was the father.

Prof. Rogers was one of a gifted quartet. His brother Henry became Regius Professor of Natural History and Geology in the University of Glasgow in 1857, and was elected a Fellow of the Royal Society in the following year. To the two brothers William and Henry, geology owes the wave theory of mountain chains—a theory deduced from an extended study of the great Appalachian chain. The eldest of the four brothers, James Rogers, served as professor of chemistry, successively, in the Philadelphia Medical Institute, the Franklin Institute, and the University of Pennsylvania. Upon his death in 1852, the youngest of the brothers, Robert, then professor of chemistry in the University of Virginia, succeeded him in the chair of chemistry at Philadelphia. It was in connection with Robert Rogers that William investigated the solvent action of water—especially when charged with carbon dioxide—on various minerals and rocks.

The wide range of William Rogers' studies and researches, his eminence among men of science in America, his enthusiasm for the advancement of knowledge, and his fraternal affinities, have all assisted in providing material for the two volumes under notice. The memoir is practically filled with letters, only sufficient editorial comment being added to make it a connected history. It would be easy to fill many pages of NATURE with interesting extracts from these letters, but the limitations of space forbid. Naturally the volumes will appeal most to Prof. Rogers' American contemporaries, and to the officers, graduates, and students of the Institute to which they are dedicated. There are, however, many British men of science who will be interested and inspired by this record of his life and work.

L'Ottica delle Oscillazioni Elettriche. By Prof. A. Righi. Pp. vii + 254. (Bologna: Zanichelli, 1897.)

TWO years ago (May 9, 1895) we drew attention to two memoirs by Prof. Righi, who in 1893 succeeded in producing and investigating the behaviour of Hertzian waves only a few centimetres in length. He has now collected the results of these and other researches, which he has made, in the form of a convenient volume, arranged in two parts. The first contains a detailed description of his apparatus, its mode of construction and use, together with the effects which can be produced by it, especially such effects as are easily exhibited by electro-magnetic waves, but only with difficulty by light-waves, on account of the extremely short wave-length of the latter. The second and longer part corresponds more closely to the title of the book, and gives an account of the following phenomena: interference-phenomena with electro-magnetic waves carried out with experimental arrangements which in the main correspond exactly to the well-known optical ones (*e.g.* Fresnel's mirror and the bi-prism); experiments analogous to the interference of light in thin plates; diffraction-experiments; absorption, transparence and opacity; reflection from the surfaces of conductors and dielectrics; experiments in reflection and total reflection which are exact analogues of optical experiments with prisms, lenses and totally reflecting prisms; elliptic and circular polarisation, and double refraction. An appendix contains a series of notes on the theory of electro-optics. The book is well printed and illustrated, and will be welcomed by all who are interested in the development of the work of Maxwell and Hertz. *pv.*

The Concise Knowledge Natural History. Edited by Alfred H. Miles. Illustrated. Pp. xvi+771. (London: Hutchinson and Co., 1897.)

THIS book of less than 800 octavo pages deals with the animal life of the world. The arrangement is systematic; the space allowed to each group is proportioned to its popular interest, and the authors have done what they could under the prescribed conditions to make their contributions readable. Since the Vertebrates occupy more than five-sevenths of the volume, the Invertebrates come off poorly. Mammals, by Mr. Lydekker, and Birds, by Dr. Bowdler Sharp, are more liberally treated, and these sections are far more interesting than the rest. It will be seen that though the book has its merits, its use is limited. We can hardly recommend it to students or to field-naturalists, or to collectors, but it will suit those who desire information about the animals which they meet, not in the flesh, but in the newspaper or book of travel. The quantity and quality of the information are equal to what would be found in any encyclopædia except the Britannica. The cuts, which are numerous, are not good; some of the frogs and salamanders, for instance, are almost unintelligible. There is a full index, which will prove a useful feature. Is it worth while to point out that there is no such plural as *Animalculæ?*

L. C. M.

Through a Pocket Lens. By Henry Scherren, F.Z.S. Pp. 192. (London: The Religious Tract Society, 1897).

GIVE this book to an intelligent boy or girl with a taste for natural history, and let it be used not merely as a reading-book, but as a guide-book to nature study, and you will do more towards cultivating the spirit of investigation than by dozens of lectures. The common idea that very little real work can be done without a compound microscope and numerous accessories has tended to discourage young naturalists, but Mr. Scherren describes so many interesting objects, all of which have been seen by him with a pocket lens, that his book will induce many to study nature who would otherwise acquire knowledge second-hand. All the examples described are taken from the Arthropoda. The group is interesting, and specimens belonging to it are so common that they can easily be procured. We have no doubt that many young students will profit by this instructive introduction to one of the main divisions of the animal kingdom.

The Young Beetle Collector's Handbook. By Dr. E. Hoffman, Curator of the Royal Natural History Museum at Stuttgart; with an Introduction by W. Egmont Kirkby, M.D. Pp. viii + 178. (London: Swan Sonnenschein and Co., Ltd., 1897.)

THIS work contains twenty coloured plates, comprising about 500 figures of Coleoptera, which may certainly, in many cases, prove of considerable service to the young beetle collector; but the letterpress is of comparatively little value, consisting, as it does, mainly of very short and more or less disjointed descriptions of selected

genera and species. In a work with such a title one expects rather to find a detailed description of the methods of procedure as regards capture, habits, habitats, &c., and not to require the young collector to plunge *in medias res* without such knowledge. The introduction certainly attempts to deal with these points, but it only consists of eleven pages of large print; and the all-important subject, in such a work, of "the habits of beetles and how to catch them" is dismissed in about thirty lines.

The plates are worth the cost of the work, which may be found useful for a somewhat more advanced student, but which hardly appears to realise our idea of a "Young Collector's Handbook."

Exercises in Practical Physiology. By Augustus D. Waller, M.D., F.R.S. Part iii. Pp. 91. (London: Longmans, Green, and Co., 1897.)

THE exercises and demonstrations contained in this and the two preceding parts are primarily intended to facilitate class work in physiology, and for use in conjunction with such a text-book as the author's "Introduction to Human Physiology." The present part contains sixty-eight instructive experiments on the physiology of the nervous system, and descriptions of the instruments used in investigations in electro-physiology generally. The subject is one which the author has made peculiarly his own; so that the experimental details will be found sufficient to enable students and demonstrators to set up the required apparatus satisfactorily and obtain good results. The book affords a strong argument for the teaching of the principles of physics to students of physiology; for without this fundamental knowledge it would be impossible to perform the experiments intelligently.

Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. Fourteenth annual issue. Pp. 270. (London: Charles Griffin and Co., Ltd., 1897.)

THIS work, in addition to being a convenient handbook of our scientific societies, contains lists of the papers read during 1896 before societies engaged in fourteen departments of research. It is thus a very useful index to scientific progress, as well as an indispensable book of reference to the officers, places and times of meetings, publications, and membership fees, of British Societies for the advancement of knowledge of every kind.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Trotting Horse.

IN "The Primary Factors of Organic Evolution," Prof. Cope, whose recent death has taken from us an untiring worker and suggestive writer, adduces the evolution of the trotting horse as an illustrative case of the inheritance of characters due to the exercise of function (p. 426). Prof. Brewer, of Yale, is quoted at some length. He says: "There is every appearance and indication that the changes acquired by individuals through the exercise of function have been to some degree transmitted, and have been cumulative, and that this has been one factor in the evolution of speed. . . . There is nothing whatever in the actual phenomena observed anywhere along the line of this development of speed that would lead us to even suspect that the changes due to exercise of function had *not* been a factor in the evolution, and there is not a particle of evidence, other than metaphysical deductions, much less proof, that it would or could have gone on just the same by mere selection and adventitious variation" (pp. 429–430).

Mr. A. J. Meston, of Pittsfield, Mass., has recently discussed this question statistically in a pamphlet entitled "The Common Sources of 2·10 trotting and pacing speed." The results of this seemingly very careful investigation are of such general biological interest, that I have no hesitation in requesting space to draw attention to Mr. Meston's conclusions.

The first point that is especially noteworthy is the predominant influence of one horse, Hambletonian 10 (1849–1876). "While we have extreme speed without the aid of Hambletonian, it is, nevertheless, a fact that the influence of Hambletonian has been exerted amongst 92 per cent. of the 2·10 trotters, and 84 per cent of the 2·10 pacers [that is to say, trotters or pacers who can cover a mile in two minutes and ten seconds or under] We have pacing speed, apart from Hambletonian, within two seconds of the best record; but trotting speed without Hambletonian is four seconds behind the fastest mile. No mile has yet been trotted faster than 2·07¾ without the aid of Hambletonian. . . . Furthermore, the majority of both the trotters and pacers that descend from Hambletonian have more than one cross of his blood. . . . A very superficial examination of the blood of the 2·10 list shows that Hambletonian has exerted a predominant influence in its formation" (pp. 6–7).

The second point is the conclusion to which Mr. Meston is led with regard to the transmission of acquired speed. "It appears from the table," he says, "that some stallions and mares, after having been trained to fast records, have got foals that made fast records. It also appears that demonstrated capacity for speed and the ability to beget speed are qualities possessed in common by many stallions and mares, but the relative dates of 'making the record' and 'getting the foal' exclude the affirmation, if not the probability, of cause and effect between the two occurrences. It does not appear that a line of trained ancestors is more successful in producing speed than a line of untrained ancestors, or a mixed line of trained and untrained ancestry. Therefore, the evidence is negative upon the question whether increase of speed acquired by the individual through training, habit, or experience, is passed on to the foal, in any degree, by the force of heredity. On the other hand, the evidence is positive and convincing that congenital capacity for speed and innate plasticity for the development of speed are transmitted hereditarily to progeny, and that, by judicious or fortunate crossing, the capacity and plasticity have been vastly increased" (p. 23).

As this is the most careful statistical investigation of the kind with which I am acquainted, it appears to me that Mr. Meston's conclusions (which, he informs me, were not those that he anticipated at the outset of his inquiry) are worthy of careful consideration. C. LLOYD MORGAN.

Bristol.

Fire-fly Light.

IN *Wiedemann's Annalen* for December last, Prof. H. Muraoka published an account of the rays which he found to be emitted by a fire-fly (described by him as a "Johanniskäfer"), and which resemble the rays which Dr. Dawson Turner has found to be emitted by glow-worms, in that they can pass (like Röntgen's rays and uranium rays) through aluminium. Can any reader of NATURE state what species of insect is known by this name? Muraoka describes them as on the average 13–15 mm. long; the largest being 20 mm. long. He says they have two (or in smaller insects three) rows of luminous spherules on the under side of its body, but that the whole body is photographically active. He used about 1000 insects at a time, with exposures of two to three days.

June 6. SILVANUS P. THOMPSON.

THE LIQUEFACTION OF FLUORINE.[1]

THE physical properties of a large number of mineral and organic fluorine compounds led to the theoretical prediction that the liquefaction of fluorine could only be accomplished at a very low temperature.

Whilst the chlorides of boron and silicon are liquids at the ordinary temperature, the fluorides are gaseous, and well removed from their boiling points. The same difference is noticeable in their organic compounds,

[1] "On the Liquefaction of Fluorine," by H. Moissan and J. Dewar. (Translated from *Comptes rendus* of the Paris Academy of Sciences, May 31, p. 1202).

ethyl chloride boiling at 12°, ethyl fluoride at −32°, propyl chloride boiling at +45°, ethyl fluoride at −2°.

Similar observations have been previously made by Paterno and Oliveri, and by Vallach and Heusler. These facts can also be connected with the experiments of Gladstone on atomic refraction. Finally, although clearly a member of the chlorine group, fluorine in some of its properties also presents some analogies to oxygen. The whole of these observations appear to clearly establish that fluorine would only with difficulty be reduced to a liquid, and it has already been shown by one of us that at −95°, under ordinary pressure, it does not change its state.

In the new experiments that we now publish, the fluorine was prepared by the electrolysis of potassium fluoride in solution in anhydrous hydrofluoric acid. The fluorine gas was freed from the vapours of hydrofluoric acid by passing it through a small platinum spiral cooled by a mixture of solid carbon dioxide and alcohol. Two platinum tubes filled with well-dried sodium fluoride completed this purification. The liquefaction apparatus consisted of a small cylinder of thin glass, to the upper part of which was joined a platinum tube. The latter contained another small tube of the same metal. The gas to be liquefied arrived by the annular space, passed into the glass bulb, and passed out again by the inside tube. This apparatus was united to the tube which led in the fluorine.

In these experiments we have used liquid oxygen as the refrigerating substance. This oxygen was prepared by the methods described by one of us, and these researches have necessitated the employment of several litres of this liquid. The apparatus being cooled to the temperature of quietly-boiling oxygen (−183°), the current of fluorine gas passed into the glass bulb without liquefying; but at this low temperature the fluorine had lost its chemical activity, and no longer attacked glass.

If now the pressure on the boiling oxygen be reduced, it is seen, as soon as rapid ebullition is produced, that a liquid trickles down the walls of the glass bulb, whilst no gas issues from the apparatus. At this moment, the exit tube is closed with the finger to prevent the entrance of any air. Before long the glass bulb becomes filled with clear yellow liquid possessing great mobility. The colour of this liquid recalls the tint of fluorine seen through a layer a metre thick. According to this experiment, fluorine becomes a liquid at about −185°. As soon as the little condensation apparatus is removed from the liquid oxygen, the temperature rises and the yellow liquid begins to boil, furnishing an abundant evolution of a gas which presents all the energetic reactions of fluorine.

We have taken advantage of these experiments to study some of the reactions of fluorine upon bodies maintained at very low temperatures. Silicon, boron, carbon, sulphur, phosphorus, and reduced iron, cooled in liquid oxygen, and then projected into an atmosphere of fluorine, do not become incandescent. At this low temperature, fluorine does not displace iodine from iodides. Its chemical energy, however, is still sufficiently great to decompose turpentine or benzene with production of flame even at −180°. It would seem that the powerful affinity of the fluorine for hydrogen is the last to disappear.

Finally, there is one other experiment that we ought to mention. When a current of fluorine gas is passed into liquid oxygen, there is rapidly produced a white flocculent deposit, which soon settles at the bottom of the vessel. If the mixture is shaken and poured on a filter, this precipitate is separated. It possesses the curious property of deflagrating violently as soon as the temperature rises. We are pursuing the study of this compound, as well as that of the liquefaction and solidification of fluorine, in which further experiments are required.

A NEW DETERMINATION OF THE GRAVITATION CONSTANT AND THE MEAN DENSITY OF THE EARTH.

An account of a new determination of these quantities, carried out in a very careful manner by Dr. C. Braun, S.J., at Mariaschein in Bohemia, has just been published in the *Memoirs* of the Vienna Academy (Bd. lxiv., Math. Nat. Classe).

Dr. Braun has been engaged on the work since 1887. He used the torsion-rod method, and though his apparatus was considerably larger than that of Prof. Boys, it was still much smaller than the older apparatus of Cavendish, Reich, or Baily. The rod was about 24 cm. long, and was suspended from a tripod by a brass torsion wire, nearly 1 metre long and 0·055 mm. in diameter. The whole torsion arrangement was under a glass receiver, about a metre high and 30 cm. in diameter, resting on a flat glass plate. The receiver could be exhausted, and in the later experiments the pressure was about 4 mm. of mercury, and the disturbances due to air currents were very greatly reduced. The attracted masses at the end of the rod were gilded brass spheres, each weighing about 54 grammes. Round the upper part of the receiver, and outside it, was a graduated metal ring, which could be revolved about the axis of the torsion wire, and from this were suspended, about 42 cm. apart, the two attracting masses. Two pairs were used: one a pair of brass spheres about 5 kgms. each, the other, a pair of hollow iron spheres, filled with mercury, and weighing about 9 kgms. each.

To determine the position of the torsion-rod, a mirror was fixed on the centre of the rod, and immediately in front of it was a mirror at 45° to the horizontal, throwing the reflexion down through the base plate on to the horizontal objective of the observing telescope; another mirror, immediately under the lens, was inclined at 45°, and sent the beam horizontally on to a graduated glass scale in the focal plane of the eyepiece. The object of which the image was viewed was an index mark on a plate placed horizontally just below the scale, and the light from it was made to traverse the axis of the telescope outwards by reflexion at a parallel plate of glass at 45° to the horizontal. As the index mark was nearly at the same distance from the objective as the scale, the rays fell nearly parallel on to the torsion-rod mirror, and the angular value of the scale divisions was determined from their length and the distance of the scale from the objective. It was also determined by a theodolite, viewing the scale through the object-glass, and found to be about 3½ min.

The instrument was fixed on a stone slab, in the corner of a room with very solid walls, and protected from temperature variations and electrical effects by a casing of cloth and tinplate.

As there was a continuous creep of the torsion-rod in one direction, amounting in the course of years to several lengths of the scale, it was necessary to have some method of moving the torsion-head. This was effected from outside the receiver in a very ingenious manner. A plate was fixed on a part of the torsion-head which did not revolve, and to this was attached a clock from which the escapement was removed, and on the axis of the escapement-wheel was fixed a small magnet. On the axis, where the driving spring had been, a pinion was fixed, gearing with a large wheel attached to the torsion-head. The magnet could be turned round by moving a magnet outside the receiver, and so the torsion-head could be slowly revolved. The gearing-down was such that, if the minute finger of the clock moved one minute, the image of the index in the telescope moved one scale division.

Vibrations of the torsion-rod were started by a light magnetised fork, which could be made to softly touch the rod on either side by the motion of a magnet outside the receiver.

The moment of inertia of the rod was determined, both by calculation and experiment, with very satisfactory agreement, and all the linear measurements of the apparatus, and of the distances, were made very carefully by horizontal and vertical cathetometers. Ingenious reflexion devices were used for measurements, which were made through the walls of the receiver.

Dr. Braun used both the deflexion method of Cavendish, and the oscillation method first used by Reich, to whom it was suggested by Forbes. In the deflexion method the attracting masses are placed outside the case, in such positions that their pulls on the attracted masses twist the rod round. The deflexion is observed, and the value of the corresponding torsion couple is determined by the time of vibration of the system. When the rod is deflected it does not, of course, take up its new position in a "dead beat" manner, but oscillates about it. The usual method of determining the centre of swing has been to observe successive elongations or turning-points, and by combining these in threes to eliminate the effect of decrement, and so to deduce the centre. But Dr. Braun found the centre more accurately by observing the times of transit of several scale divisions near the centre, in both directions. By interpolation he could determine the point about which the time of oscillation in either direction was the same, and this was taken as the centre of swing. The deflexion observed was about 13 divisions of the scale. The times of transit were registered on a chronograph.

The wire showed a certain amount of elastic after-action, and by subsidiary experiments on a similar wire this was as far as possible allowed for.

In the oscillation method the attracting masses are placed in a line with the torsion-rod, one at each end. Their attractions then act, not to deflect the rod, but to increase the restoring force, and so to lessen the time of vibration. The attraction is determined by comparing the times of vibration when the masses are in position, and when they are removed, or when they are placed so that the line joining their centres is at right angles to the rod.

The time of vibration observed by Dr. Braun was about 1275 seconds, and when the masses were put in position this was altered by about 46 seconds.

The results obtained in the years 1892 and 1894 were finally used, and these gave for the mean density of the earth—

	1892		1894
Deflexion method	5·529	...	5·526
Oscillation ,, ...	5·520	...	5·531

Giving due weight to the various observations, the final result is practically identical with that of Prof. Boys', viz.:

$$\text{Mean density} = 5{\cdot}52725 \pm {\cdot}0012$$
$$\text{Gravitation constant } G = 665{\cdot}786 \times 10^{-10}$$

J. H. P.

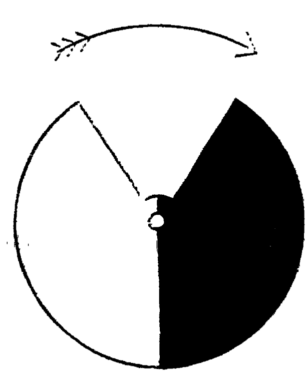
SUBJECTIVE TRANSFORMATIONS OF COLOUR.

IN a communication to the Royal Society on May 13, I described some curious experiments, showing how coloured objects might apparently be made to assume tints which were complementary to their actual hues—red, for example, appearing as green or greenish-blue, and green as pale red.

The phenomenon depends upon the rapid generation of negative after-images of the kind demonstrated by the familiar experiment with the red "wafer." If a red wafer lying upon a sheet of white paper is looked at steadily for about half a minute, and the gaze is then suddenly transferred to some other part of the paper, a greenish-blue ghost of the wafer will be seen. The portion of the retina upon which the red image at first falls becomes fatigued and partially insensible to red light; it is therefore unable to appreciate the red component of the white light afterwards reflected to it, and the sensation of the complementary colour consequently predominates.

The new experiments indicate that the preliminary stare may, under certain conditions, be an exceedingly brief one. In a paper published three years ago (*Proc. Roy. Soc.*, vol. lvi. p. 132) I called attention to an observation indicating that a short period of darkness imparts to the retinal nerves a degree of sensitiveness, which is far above the normal average in the light, and which quickly passes away again under the influence of illumination. This peculiar sensitiveness is in fact both acquired and lost in a small fraction of a second, and is therefore very favourable for the rapid production of negative after-images.

Let two small screens—one black and the other white—be held together in one hand, and arranged so that there may be a triangular gap between them. Let the black screen first cover the paper upon which the wafer is lying; this will darken a portion of the retina, and render it sensitive. Then let the screens be quickly moved sideways, so that the wafer may for a moment be exposed to view through the gap, the movement being stopped as soon as the paper is covered by the white screen. A bright but evanescent greenish-blue ghost will succeed the red impression. But the curious thing is that if the illumination is strong, and the screens are moved at the proper speed, no trace of red will be seen at all; it will appear exactly as if the actual colour of the wafer were greenish-blue. The action of light after a short period of darkness seems to have the power of appreciably diminishing the sensibility of the retinal nerve-fibres in a space of time so short, that if the light be coloured its colour is not consciously perceived. I am informed that analogous phenomena have been observed in other branches of physiology; a well-defined reaction sometimes occurs when no direct evidence can be detected of the existence of the excitation to which the reaction must have been due.



By the use of a rotating disc having a black and white[1] surface and an open sector, as in the annexed figure, the effect can be shown continuously. The disc is made to turn some six or eight times in a second, while its front surface is strongly illuminated either by bright diffused daylight or by a powerful lamp. An incandescent lamp of 32 candle-power at a distance of six inches gives excellent results; it should be placed opposite the disc, and should be provided with a small tin reflector to protect the eyes from the glare. A red card placed behind the disc is made to appear green, a green card pink, and a blue one yellow, while a black patch painted upon a white ground appears whiter than the ground itself. At the conversazione of the Royal Society on May 19, I exhibited some designs which had been prepared for the purpose of demonstrating the phenomenon in a striking manner. Among them was a picture of a lady with indigo-blue hair, an emerald-green face, and a scarlet gown, who was represented as admiring a violet sunflower with purple leaves. Seen through the disc the lady's tresses appeared flaxen, her complexion a delicate pink, and her dress a light peacock-blue, while the petals of the sunflower became yellow and its leaves green. Other designs showed equally remarkable transformations of colour.

SHELFORD BIDWELL.

[1] A pale brownish-grey tint is better than pure white.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

THE fourth meeting of the Congrès Internationale de l'Enseignement Technique, to be held this year in London, on the invitation of the Society of Arts and the Worshipful Companies of Mercers, Fishmongers, Drapers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers and Carpenters, will be opened on June 15 by an address from the President, the Duke of Devonshire, and from the President of the last Congress, Mr. Léo Saignat.

This meeting of Congress, the previous meetings of which were—in 1886 (at Bordeaux), in 1889 (at Paris), and in 1895 (at Bordeaux), appears likely, if one may judge of the interest it is exciting, to be a success.

Invitations were sent through our Foreign Office to Foreign Governments to appoint delegates, and up to the present notice has been received of the appointment, by Belgium, of M. Eugène Rombaut, Inspector-General of Industries and Professional Education, M. Wanters, Assistant Inspector, and Dr. Pyffersen, of the University of Gand, and, by France, of M. Félix Martel, Inspector-General of Public Instruction. Invitations have also been sent to the Technical Instruction Committees of County Councils, and other bodies and institutions interested in the subject, to appoint representatives, and have met with a hearty response; also to bodies and institutions abroad of a like character, in which case an equally satisfactory result is expected.

There are also a large number of persons who, by the payment of the modest subscription of 5*s*., have become members of the Congress, and as such are entitled to all the privileges of the Congress.

After the opening addresses, the Congress will break up into two Sections—the subjects to be discussed, which have reference only to advanced and secondary instruction, falling under the heads of Industrial and Commercial Education—to meet simultaneously from 11 to 1 and 2.30 to 5 each day; one at the Society of Arts, the other at the London School of Economics, until Friday, at 2.30, when there will be the concluding meeting of the combined Sections. The list of those who have up to the present promised papers, so far as this country is concerned, is decidedly a strong one, containing, as it does, the names of Sir J. Donnelly and Sir H. T. Wood, who will deal with the part taken by the Society of Arts in the matter of technical education; Dr. Wertheimer and Mr. Dixon, on subject of examinations; and Prof. Ayrton, Mr. Redgrave and Mr. Macan, on State and legislative interference; Sir J. Fitch, Prof. Thompson, Mr. Slingo and Mr. Turner, on reforms and limitations; Mr. Wells, on the training of teachers; Prof. Garnett, Mr. Hogg and Mr. Sachs, on training bodies; Dr. Armstrong and Dr. Gladstone, on chemical education; Mr. Ablett, on drawing; Mr. King and Mr. Swire Smith, on evening schools; and, on the commercial side, Dr. Wormell, Mr. Webb, Mr. Eve, Mr. Hewins, and Mr. Organ. Sir P. Magnus will speak on theory and practice in trade education, and there will be a series of papers from practical men on the subject of technical education as it affects particular industries and agriculture. There will be a joint Indian paper from Mr. Baines and Mr. Bhownaggree, and one each from seven of our colonies by a man of official position and educational experience in the colony to which the paper relates. The ladies will be represented by the Countess of Warwick, on rural districts; Miss Hughes, on technical education of girls and women; Miss Pycroft and Miss Mitchell, on domestic economy; and Miss Calder and Miss Walter, on domestic science.

The list of foreign papers is, as yet, far from complete; but amongst the contributors from abroad may be mentioned, in addition to those already referred to, Dr. Witt (of Berlin), Prof. Lunge (of Zürich), M. Siegfried and M. Mesureur (of Paris), M. Ed. Sève (of Belgium). Arrangements are being made to enable our foreign visitors and others to become acquainted with the work being done in the matter of technical education, and also for their entertainment. Under the last head may be mentioned the evening reception at the Mansion House, on June 17 (to which the Lord Mayor has kindly invited the members of the Congress), the Society of Arts conversazione on June 16, and an excursion for foreign delegates to be arranged on June 19.

JAMES WYLLIE RODGER, A.R.C.S.

BY the death of J. W. Rodger a young life of great scientific promise has been cut short. He was born at Stewarton, N.B., on December 11, 1867, and was educated at Kilmarnock Academy, under Dr. Dickie, and at the Royal College of Science, London. His college career was interrupted by illness, but he won all the chief prizes, and took a very active part in the management of the college societies. In 1889 he was appointed assistant in the research laboratory, with the result that in the course of the next five or six years a number of papers were published, of which he was joint author with Dr. Thorpe. One of the most important of these, "On the relations between the viscosity of liquids and their chemical nature," was printed in the *Philosophical Transactions*, and was the subject of the Bakerian Lecture in 1894. By a kindly arrangement the lecture was delivered by the younger of the two authors, and no one who was present is likely to have forgotten how well Rodger acquitted himself of his task. It was an admirable piece of exposition. He spoke quickly, but with perfect distinctness; with modesty, but without apparent nervousness or hesitation. Every point was made clear, and at the end it was the general opinion that the Bakerian Lecture had rarely, if ever, been better given than by the youngest Bakerian Lecturer.

A continuation of the work on viscosity, by the same authors, appeared in the *Transactions* in March of the present year.

At the end of 1895 another important paper by Rodger and his friend, Mr. W. Watson, was also published in the *Transactions*. The subject was "The magnetic rotation of the plane of polarisation of light in carbon bisulphide and water."

In addition to these labours Rodger wrote often and well in NATURE and in *Science Progress*, chiefly choosing subjects connected with chemical physics.

Of singularly attractive appearance and manners, popular with his fellows, a good teacher, and a first-rate lecturer, he had done enough solid work to prove that, if life and health were spared, he would win an honourable place in the ranks of English science. But it was not to be. Some time ago serious delicacy of the chest developed, and ten days ago he died before completing his thirtieth year.

A. W. R.

NOTES.

AT the annual meeting for the election of Fellows of the Royal Society, held on Thursday last, the candidates whose names and qualifications we have already published (p. 54) were elected into the Society.

THE Vienna Academy of Sciences have elected as foreign members: Profs. Vogel and Bezold of Berlin, Prof. Gegenbaur of Heidelberg, Prof. Max Müller, and Lord Lister.

THE President and Council of the Royal Geographical Society will hold a reception at the Natural History Museum this evening.

THE French Association for the Advancement of Science will hold its twenty-sixth meeting at Saint Étienne on August 5–12, under the presidency of M. Marey.

MR. PERCY S. PILCHER has invited a number of friends and persons interested in aerial navigation to witness one of his experiments with a soaring machine at Upper Austin Lodge, Eynsford, Kent, on Saturday afternoon, June 19.

THE important discovery by two Japanese botanists, of the existence of spermatozoids in certain flowering plants (*Ginkgo biloba* and *Cycas revoluta*), has already been recorded in the pages of NATURE (vol. lv. p. 396). Original preparations, by Prof. Ikeno and Dr. Hirase, illustrating their discovery, will be exhibited by Dr. D. H. Scott, F.R.S., at the next meeting of the Linnean Society, on June 17. This will be the first occasion on which this remarkable observation, obliterating one of the chief supposed distinctions between Phanerogams and Cryptogams, has been demonstrated to European botanists.

THE annual meeting of the Iron and Steel Institute will be held at Cardiff on August 3–6, under the presidency of Mr. Edward P. Martin. A detailed programme will be issued when the arrangements are further advanced.

THE Croonian Lectures of the Royal College of Physicians will be given by Dr. Hale White, at the Examination Hall, on June 15, 17, 24, and 29. The subject of the lectures is "The means by which the temperature of the body is maintained in health and disease."

THE forty-second annual exhibition of the Royal Photographic Society will be held from September 27 to November 13. Negatives, transparencies, photo-mechanical prints, stereoscopic work, photographs of purely scientific interest, and photographs coloured by mechanical means will be admitted to the exhibition, and medals will be awarded by the Judges. Exhibits must reach the Secretary of the Society, 12 Hanover-square, London, W., on or before September 8.

WE regret to have to record the following deaths:—Dr. Julius von Sachs, Professor of Botany in Wurzburg University, and Foreign Member of the Royal Society; M. Slouguinoff, Director of the Physical Institute of the Imperial University of Kazan; Mr. H. B. Chamberlin, who presented the Chamberlin Observatory to Denver University, and in other ways assisted in the advancement of science; Mr. William Godward, formerly of the Nautical Almanac Office, and author of some useful astronomical tables; M. Manen, Correspondant of the Section of Geography and Navigation of the Paris Academy of Sciences; and Baron Oscar Dickson, who fitted out several Arctic expeditions, including the Vega expedition of Baron Nordenskiold.

THE organisation and federation of local scientific societies is a work well worth doing. Prof. Meldola pointed out in these columns a year ago (vol. liv. p. 114) how science would be better served if the efforts of the legion of amateur naturalists were co-ordinated by the formation of groups of societies. The South-eastern Union of Scientific Societies is a group of this character, and the success of the congress which the Union held at Tunbridge Wells towards the end of last month, under the presidency of the Rev. T. R. R. Stebbing, F.R.S., will, we hope and believe, lead to the federation of other local societies. The societies which have joined the Union are almost exclusively natural history societies. They are friendly to philosophy and literature, to mathematics and chemistry, to agriculture and political economy, to astronomy and the use of the globes; but they find their own more special and serious employment in zoology, botany, and geology. What the British Association does on an imperial scale, the Union hopes to do for a limited area. The pursuit of natural knowledge will thus be encouraged, the results of investigations will be made more widely known, and, best of all, public opinion will be enlightened as to the value of scientific work.

NOTHING is worse than fog at sea. A storm may cause discomfort, an accident may cause delay, but in neither case does the traveller feel so helpless as when his vessel is completely shut in by a dense fog. To lessen the danger which then exists, Prof. E. C. Pickering, the Director of the Harvard College Observatory, suggests, in a pamphlet just received, a method of determining the position of a vessel in a fog, based upon the velocity of sound. If two fog-horns of different pitch be placed at equal distances from the middle of a channel or entrance to a harbour, and be sounded simultaneously at regular intervals of about a minute, it will be evident that a captain of a vessel will be able to locate his position with fair accuracy by noting when the sounds of the horns are heard. If the two sounds are heard at the same instant the vessel will be in the middle of the channel, and if they are heard after one another it would be possible to judge from the interval between the two how much the vessel is out of the middle of the channel. For vessels passing one another, Prof. Pickering suggests that each should whistle or blow the horn or syren as soon as the sound is received from the other vessel. Then, if they are five miles apart, each will whistle every fifty seconds, and the distance in miles between the two vessels can always be determined by dividing the interval in seconds by ten. By placing two different fog-whistles on a long steamer, one at the bow and the other at the stern, and arranging that the sounds emitted by both should be heard together by an observer standing at the bow, many collisions might be prevented. Instructions could be given to sailing vessels to keep quiet so long as both signals were heard separately, for they would then be in no danger, but to fire a gun or make other loud noise when both whistles were heard together, for they would then be in front of the steamer. These various methods may be combined indefinitely, and they seem to be worth the consideration of navigators.

AN appeal is being made to iron-masters of the various important iron-making countries for annual subscriptions towards the maintenance of a central laboratory for the testing of iron and steel, to be founded at Zürich under the auspices of the International Society for Testing of Materials of Construction. The Society was founded at a congress held at Zürich in 1895, and none of the tasks which it has imposed upon itself are of greater importance, while none present greater difficulties, than the unification of the methods for the chemical analysis of iron and steel. Efforts have been made in several countries for some years past to lay the foundations of a better knowledge of this subject. But whilst to the fullest extent recognising the very great value of the work already done locally, the Council of the International Society decidedly believes that the work hitherto done in many isolated places should be brought together in a common focus where it would be classified, compared, and reduced to a common standard. Such a central laboratory would also have the task of following the progress of both industry and science, of examining all new methods of any importance brought forward in various quarters, of searching for new methods whenever new problems were presented, and of serving as a guide to the individual chemists when they were beset by the difficulties inseparable from their avocation. Zürich has been chosen as the seat of the institution; and ample accommodation has been secured in the magnificent chemical laboratory of the Federal Polytechnic School. The Federal Council has granted the use of these rooms, free of rent, for the projected central laboratory. Hans von Jüptner, chief chemist of the Neuberg Iron and Steel Works in Austria, has been appointed as the head of the laboratory. 2000*l.* per annum is

required for the maintenance of the laboratory, and it would be impossible to start the laboratory unless this amount was secured for, say, ten years. Looking at the immense importance such a central laboratory is likely to acquire for the whole of the iron industry, and the very large pecuniary benefit ultimately following therefrom, there should not be much difficulty in obtaining promises of subscriptions to the amount required. Mr. Bennett H. Brough, the Secretary of the Iron and Steel Institute, has undertaken to receive subscriptions, and to forward them to the International Society.

FOR a period of about eight years a portion of the staff of the Meteorological Office has been busily engaged in the discussion of observations for the preparation of Monthly Current Charts of the Atlantic Ocean. The observations are contained in about 5500 logs, principally of merchant vessels, collected by the Meteorological Office since the year 1854, and about 13,000 logs kept on board H.M. ships since 1830. The charts for six representative months, referring both to the North and South Atlantic, have been prepared for publication under the superintendence of the Hydrographer of the Admiralty, and are issued in the form of Admiralty charts. They bring to light various interesting points which are masked by charts referring to longer periods; for instance, the Gulf Stream, from which this country is supposed to derive much of its warmth in winter, is shown to flow with varying velocity according to the season, the rate being about 100 miles a day in June, in the Straits of Florida, while in October and November it does not exceed 70 miles a day, and at times only amounts to about 20 miles; and the Guinea and equatorial currents are shown to undergo considerable variations according to the time of the year. Generally speaking, the oceanic circulation can now be studied in a manner that was not possible before the publication of monthly charts, and the results cannot but prove to be of the greatest utility both to seamen and men of science.

MR. H. C. RUSSELL, Government Astronomer of New South Wales, has published, in a recent number of the *Proceedings* of the Royal Society of that colony, a chart showing the tracts of 154 current papers collected during the past two years. The lines plotted on the chart are the shortest tracks between the points where the bottles were thrown into the sea and where they were found. The routes taken by the bottles are interesting: most of them were found on the coast between Melbourne and Adelaide; fifteen were picked up on the east coast of Australia—three of these went to the south, eight went to the north, and four came in from the east. Mr. Russell remarks that, in view of the well-known southerly current on this coast, it is remarkable that so few of the papers seem to go with it, and that the majority of the papers found go against it. The prevailing wind seems to have a decided action in the direction of the drift of the bottles. Three papers, thrown overboard off Cape Horn, followed nearly the same tracks; one was picked up on the west coast of Australia, and the others on the coast of Victoria: their daily rates, over a distance of about 9000 miles, being 9·0 miles, 7·9 miles, and 10·3 miles respectively.

AN interesting collection of prehistoric flint instruments which Mr. H. W. Seton-Karr discovered in Egypt last November, and which he believes to come from the lost flint mines of Egypt, was recently exhibited by him at the Royal Archæological Institute. The collection also included a number of specimens of what Mr. Seton-Karr considers to be the most perfectly preserved palæoliths hitherto discovered. The flint mines are situated in the Eastern Desert of Egypt, some at a distance of about 30 miles from the Nile, some nearer, in the Wady-el-Sheik district. Of palæolithic implements of the earliest date he found but two at the mines. The remainder came from Abydos, Nagada, Nagh Hamadi, Thebes, and other places in the Western Desert. At some of the mines were shafts about 2 feet in diameter, filled up with drifted sand, and surrounded by masses of excavated rock neatly arranged. There was usually a central work-place where most of the objects were discovered. But in some mines a number of clubs or truncheons lay distributed uniformly, as though hurriedly left when the mines were last abandoned, at a period probably long anterior to historic record. The results of Mr. Seton-Karr's sixth and latest expedition were shown in the implements of flint and quartzite from Somaliland. With respect to these discoveries, Sir John Evans remarked in a communication made to the Royal Society, that they "have an important bearing on the question of the original home of the human race. Of their identity in form with some from the valley of the Somme and other places there can be no doubt, and we need not hesitate in claiming them as palæolithic. The cradle of the human race must have been situated in some part of the world where the climate was genial and means of subsistence readily obtained."

IT is depressing to think that there exist not only private persons, but public bodies who put more trust in the wild assertions of charlatans than in the matured conclusions of science. The latest instance of gullibility of this character comes from Bedfordshire. The Urban District Council of Ampthill were ordered by the Local Government Board to procure a water supply within a limited time, the Council being given a free hand how to go to work, and they thereupon unanimously resolved to employ a water diviner. Accepting the recommendations of this gifted gentleman, the District Council applied for a loan to carry them out. But, fortunately for common-sense, when the Government auditor recently sat to audit the accounts of the Urban District Council of Ampthill, several ratepayers raised objections to an expenditure incurred in the employment of the water diviner. They produced geological plans and sections to show that, if the diviner's recommendations were acted on, the Council would be boring into a stratum of Oxford clay, the depth of which had not been fathomed as yet, although a boring had been made to 700 feet, and no water obtained. The auditor, in announcing his decision to disallow the payment, stated that in seeking for water the District Council had disregarded the reports of experts, and had gone for guidance to a man who had a reputation for discovering water by some unusual and peculiar method not possible to ordinary persons, and the question he had to settle was whether this was legal or not. Money might properly be spent on experimental borings under proper advice, but it had not been proved that the diviner employed had any greater power than any one else. It had been held that "the pretence of power, whether moral, physical, or supernatural, with intent to obtain money, was sufficient to constitute an offence within the meaning of the law," and he, therefore, thought that, as the diviner claimed to exercise some such power, his employment was clearly illegal, and the amount of his fee would, therefore, be disallowed, and the gentlemen who authorised the payment surcharged with it. The decision will assist, perhaps, in reducing the number of believers in the water diviner's art.

FOR those men of science who may be induced to travel over Siberia, now that they can do it by rail, we notice that a new interesting museum is being opened at Chita, the chief town of Transbaikalia, in connection with the Transbaikalian Section of the Russian Geographical Society. Rich collections relative to Buryate buddhism, and good collections of objects belonging to natural sciences, archæology, and occurrence of gold in mines, rapidly accumulate in that new little museum, to which a botanical garden is to be annexed.

THIS year's exhibition of the Russian Archæological Commission at St. Petersburg, containing the collections made in the years 1895 and 1896, offers a special interest. Besides a great number of most valuable classical antiquities discovered at the sites of old Greek colonies on the Black Sea, it contains very interesting collections of stone-age implements and pottery from Kieff, Tiflis, and Poland; of the intermediate age between the stone and the bronze period from various parts of Central Russia; and very rich collections of bronze weapons and implements from Caucasia, Saratoff (a splendid bronze helmet), Tomsk, and Yeinseisk. Among these latter the miniature copies of various implements of that period deserve a special mention.

THE last number of the *Journal of the Russian Physical and Chemical Society* (xxix. 3) contains an obituary notice, devoted to the memory of Dr. Véra Bogdanovskaya-Popoff, who was killed on May 8 in her own laboratory at Izhora, by an explosion. She had been working to obtain a combination, analogous to prussic acid, in which nitrogen would be substituted by phosphorus. When Mlle. Bogdanovskaya came to Geneva, in 1890, to study under Prof. Groebe, she intended to carry on that investigation, but was dissuaded by Prof. Groebe, and made, instead, a research on dibenzyl ketone (*Chemische Berichte*, xxv., 1892), for which she received at Geneva the degree of Doctor of Sciences. Returning to Russia in 1892, she was assistant to Prof. Lvoff, at the High Courses for Ladies, and devoted much of her time to aid the beginners in grasping the principles of chemistry. She lectured also upon stereo-chemistry, which she had studied under Prof. Guye; and finally, in her own laboratory in the neighbourhood of St. Petersburg, returned to the work on the phosphorus analogues of prussic acid. She fell a victim of an explosion which took place during that dangerous investigation.

AMONG recent American botanical papers received are "New Studies upon the Smut of Wheat, Oats, and Barley," issued from the Government Agricultural Experiment Station for North Dakota; and the completion of Dr. Millspaugh's "Contributions to the Coastal and Plain Flora of Yucatan," published by the Field Columbian Museum.

THE Deutsche Seewarte has just issued a volume entitled "Segelhandbuch" for the Pacific Ocean, intended to accompany the Atlas of Charts for that ocean, which appeared some time ago. The work is divided into a large number of chapters, written by the staff of the Seewarte and other experts, and contains the results of experience gained by the discussion of an immense number of trustworthy observations, mostly made on board German vessels, relating both to air and sea. The Seewarte has now issued these useful atlases and handbooks for all the large oceans.

IN a recent number of the *Proceedings* of the Boston Society of Natural History Mr. Gerrit S. Miller, jun., gives an account of the mammals of Ontario, based on collections made in different parts of that province in 1896. To these are added notes on the same subject, made by Mr. Allan C. Brooks during ten years' residence in the counties of Wellington and Hamilton. While we fully allow that science is cosmopolitan, it could be well wished that our Canadian friends would pay a little more attention to the fauna of their own country, and not suffer it to be entirely in the hands of their more active brethren of the United States. We trust that the proposed establishment of a Professorship of Zoology at McGill University, Montreal, may have a good effect in this direction.

THE last number of the *Annali d'Igiene Sperimentale* contains a paper by Dr. Massone, on the presence of tubercle bacilli in the milk supplied in Genoa. Forty-four different samples of milk were collected, and were submitted to a careful microscopic examination, but in no case were tubercle bacilli discovered. When, however, the further test was employed of first submitting the various milk samples to the centrifugal machine, and then inoculating the layer of cream and the deposit thus obtained into guinea-pigs, three out of the forty-four samples were found to contain tubercle bacilli, for three of the animals thus treated succumbed to tuberculous infection. Dr. Massone points out how important it is that all tests of milk for tubercle bacilli should be made by direct inoculations into animals, as no trust can be placed on microscopic evidence as to the freedom of milk from this species of infection. In conclusion the author emphasises once more the inconsistency which attends the severe restrictions imposed in many places upon the sale of meat obtained from tuberculous animals, whilst no attention is paid, or public importance attached, to the prevention of milk being distributed infected with these noxious germs. In the former case, owing to the meat being cooked before use, less danger attaches to its consumption, whilst the unfortunate custom which prevails of drinking milk in its raw unsterilised condition, renders the use of contaminated milk a greater menace even to the health of the community than the distribution of tuberculous meat.

EVERYTHING concerning the Island of Jamaica, from its discovery by Columbus in 1494 to the present time, will be found in the admirable "Handbook of Jamaica," published by authority (Mr. Edward Stanford is the London agent), and prepared by Mr. S. P. Musson and Mr. T. L. Roxburgh. At the end of the chronological history of the island, reference is made to the publication of Prof. Williams' report on the cattle disease in Jamaica. The conclusion arrived at is that the disease "is a chronic form of Texan fever conveyed from place to place and transmitted from one animal to another through the intervention of the Tick. The infection is conveyed by the progeny of Ticks which have matured on infected cattle, and is inoculated by them directly into the blood of susceptible cattle." Remedies for the destruction of the Tick are suggested in the report.

THE New Zealand Institute has just commenced to publish, in quarto form, a series of reproductions of photographs of the remaining monuments of Maori skill and art, with short descriptions of the specimens figured. The author of this important descriptive work, Mr. Augustus Hamilton, Registrar of the University of Otago, has, with his camera, visited many outlying parts of Maoriland with great enterprise and success. The pictures obtained by him have been photographically reproduced in extremely fine tone; so that the complete collection will preserve for the ages the characteristics of the ornamentation of the Maoris, when the "devouring tooth of time" has obliterated the originals. It is hardly necessary to explain to readers of NATURE that a publication of this character is of the highest value. The first part, which has just been issued, describes the canoes of the Maoris and the carvings upon them; this, with four other parts illustrating the dwellings, weapons, dress and decoration, and social life, will complete a volume. It is expected that Part ii. will be ready next August.

IN the Catalogue of the Vienna Exchange Office for Cryptogamic Plants, conducted by Herr J. Brunnthaler, Igelgasse 11, Vienna, iv/2, are offered for exchange or sale some 600 Mosses, 140 Hepatics, 940 Fungi, 580 Lichens, 690 Algæ, and 48 microscope slides. The value attached to every specimen is expressed in the units (twentieths of a shilling) adopted for convenience of exchange, the valuation depending on the quality and rarity of the specimen. Numerous regulations are given as to the condition, preparation, and labelling of specimens sent for exchange to the Office. Lists of such specimens as can be supplied for exchange must reach the office by September 15. From the parcels subsequently sent in a deduction of 25 per cent. of the

total value is made for the benefit of the Office. The valuation of European plants is settled by the director, who is willing to receive Vascular Cryptogams and Bacteria in addition to the groups mentioned above. Descriptions of some new species of Fungi are published in the current Catalogue.

DR. RICHARD HERTWIG'S "Lehrbuch der Zoologie," which was reviewed in NATURE in June 1893 (vol. xlviii. p. 173), has reached a fourth edition. The section on the Sporozoa has been revised, and some additions have been made in the section on the Vertebrates. The work is published by Gustav Fischer, Jena.—Messrs. Blackie and Son have published what is nominally a fourth edition of Mr. Jerome Harrison's "Text-Book of Geology"; but the additions and changes are so numerous that the work is practically a new one, the type having been entirely re-set. The book is "intended as an introduction to the study of rocks and their contents," and it will, we believe, be the means of adding to the number of out-door students of geology, notwithstanding the fact that it belongs to the class of examinational text-books. The text is clearly printed, and the illustrations are numerous and generally instructive.—Messrs. J. and A. Churchill have published the second edition of "A Manual of Botany," by Prof. J. Reynolds Green, F.R.S. Very few changes have been made in the work.

WE have upon our table a number of important geological memoirs and reports lately published. Geologists will be glad to have their attention drawn to these publications. From the Geological Survey of India we have received the first memoir of a new series (Series xvi.) of the Palæontologia Indica, intended to comprise a description of the fossils found in Baluchistan. The first part of the new series comprises the Jurassic Fauna of Baluchistan, and in the present memoir, Dr. Fritz Noetling deals with the fauna of the Kellaways of Mazár Drik. The geology of the Bellary district, Madras Presidency, is described by Mr. R. Bruce Foot in vol. xxv. of the memoirs of the Survey; and the geology of Hazara and the Black Mountain is dealt with by Mr. C. S. Middlemiss in vol. xxvi. of the same memoirs. Both of these papers are full of details referring to the geology of the district surveyed by the authors, and each of them throws light upon problems of more than local interest.

A REPORT on explorations in the Labrador Peninsula along the East Main, Koksoak, Hamilton, Manicuagan, and portions of other rivers, made by Mr. A. P. Low in 1892–95, has been published by the Geological Survey of Canada (Part i., Annual Report, vol. viii.). This is an interesting account of exploration, containing much new information in regard to the geology and natural history of the Labrador Peninsula. A concise and readable summary of the observations made, and the conclusions reached from them, takes up one part of the report, and the remainder consists of detailed descriptions of the routes, the rocks noted, and other observations for the use of future explorers in the region traversed. Lists and notes on the fauna and flora of Labrador, and a meteorological record are printed as appendices to the report. We have also received Part R of the same annual report (vol. viii.) containing an account of the work carried out in the Laboratory of the Survey during 1896, by Dr. G. C. Hoffmann. In this report reference is made to several interesting and, in some instances, valuable minerals, not before known in Canada. Two other recent publications of the Geological Survey of Canada are: "Report on the Country between Athabasca Lake and Churchill River," by Mr. J. Burr Tyrrell, assisted by Mr. D. B. Dowling; and "Palæozoic Fossils," by Mr. J. F. Whiteaves. The latter paper is the third part of the third volume on Palæozoic Fossils now in course of publication by the Canadian Survey.

THE twenty-second and twenty-third annual reports of the Geological and Natural History Survey of Minnesota, referring to the work done during 1893–94, have been received from the State Geologist, Mr. N. H. Winchell. The latter report contains a paper by Mr. Winchell on "The Origin of the Archean Greenstones." The paper is a critical examination of a paper by Dr. G. H. Williams, tending to the conclusion that the greenstones, as a body, may be referred to dynamic metamorphism of massive eruptive rocks. Mr. Winchell believes "that the great bulk of the 'greenstones' as an Archean terrane, ought to be classified as pyro-clastic, *i.e.* that they originated from eruptive agencies, as tuff and all kinds of volcanic débris, sometimes very coarse, and were distributed and somewhat stratified by the waters of the ocean into which the materials fell."

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*, ♂ ♀), two Crested Porcupines (*Hystrix cristata*) from South Africa, presented by Mr. J. E. Matcham; a Brown Bear (*Ursus arctos*), European, presented by Mr. William Forbes; a Black-necked Grackle (*Gracupica nigricollis*) from China, presented by Mr. B. H. Jones; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by Mrs. Doyne; five Common Chameleons (*Chamæleon vulgaris*) from Egypt, presented by Dixon Bey; a Ring-tailed Lemur (*Lemur catta*), two Black-headed Lemurs (*Lemur brunneus*) from Madagascar, two Korin Gazelles (*Gazella rufifrons*, ♂ ♀) from Senegal, a Fennec Fox (*Canis cerdo*), six Egyptian Foxes (*Canis niloticus*), a Pale Genet (*Genetta senegalensis*), three Leith's Tortoises (*Testudo leithi*) from Egypt, a Harnessed Antelope (*Tragelaphus scriptus*, ♀) from West Africa, deposited; a Californian Sea Lion (*Otaria californiana*, ♀) from the North Pacific Ocean, two Ostriches (*Struthio camelus*, ♂ ♀) from Africa, purchased; a Long-legged Jackal (*Canis variegatus*) from North-east Africa, three North African Jackals (*Canis anthus*), a Striped Hyæna (*Hyæna striata*) from Egypt, received in exchange; an Eland (*Orias canna*, ♂), a Patagonian Cavy (*Dolichotis patachonica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LATITUDE OF THE ROYAL CATANIA OBSERVATORY.—The Italian Royal Geodetical Commission have just published a detailed account of the determination of the latitude of the Royal Astronomical Observatory of Catania by Dr. T. Zona, of the Royal Observatory of Palermo. All the observations were made during the year 1894, and the method adopted was that of Talcott. The pairs of stars used amounted to twenty-three in number, and their places were obtained from each of the three separate catalogues, viz. Respighi, Bradley-Auwers, and the British Association Ten-Year.

Dr. Zona has not attempted to amalgamate the positions of each star as given by the three separate catalogues, by using a mean value, but has preferred to determine three values for the latitude, basing each on the separate catalogue star positions for the pair employed.

In this way computation has given for the final values of the latitude, based on the star positions of each catalogue, the following results:—

Respighi	$37° 30' 13''.239 \pm 0''.115$
Bradley-Auwers	13.216 ± 0.132
Ten-Year	13.302 ± 0.108

The final value adopted for the latitude of the transit instrument of the observatory was

$$37° 30' 13''.254 \pm 0''.068.$$

PHYSICAL AND MICROMETRICAL OBSERVATIONS OF VENUS.—The amount of detail visible on the disc of Venus is not so very prominent, according to the observations recently recorded by Prof. Barnard (*Astrophysical Journal*, vol. v. No. 5). Those observers who up to the present time have only made out dusky

patches on her surface will feel satisfied that this well-known observer has not yet detected such tracings as have been put before us by Lowell. Venus was frequently observed by him with the 12-inch refractor of the Mount Hamilton Observatory during the years 1888–95, but as he says he "never could (with but one exception) satisfactorily see the markings. Vague indefinite spots were often visible, but it was not possible to see them well enough to identify them for rotational purposes." With these facts before us, it is not then surprising that the observed periods of the planet should vary from twenty-three or twenty-four hours to 225 days. The exceptional case of good seeing mentioned above was "when the air was thick with smoke and dust. . . . I was struck with the remarkably perfect definition. There was not the slightest tremor. The markings on the surface of the planet were distinctly seen, though they were difficult and very delicate." The drawing which accompanies Prof. Barnard's description shows the crescent of Venus with four large hazy patches very much foreshortened in their position near the limb.

To continue his series of measurements of the diameters of all the planets with the 36-inch, Prof. Barnard, in May, June and July of 1895, undertook that of Venus. The mean of all his measures reduced to unit distance gave a diameter of 17″·397, corresponding to an actual diameter of 7826 miles.

This value seems to be very satisfactory when compared with the mean of all previous determinations, as will be seen in the following table.

Hartwig	... Breslau heliometer	17″·67
,,	... Reduction of Oxford measures ...	17·582
,,	... Double image observations by Kaiser	17·409
,,	... Nine measures in Bahia-Blanca ...	17·406
Peter	... Two measures in Bahia-Blanca ...	17·216
Küstner	... Two measures in Punta Arenas ...	17·312
Auwers	... Measures during transit	16·801
Ambronn	... Göttingen heliometer	17·711
	Mean	17·389
Barnard	... 36-inch Lick refractor...	17·397

NEBULÆ UNRECORDED IN CATALOGUES.—In the current number of the *Observatory*, Dr. Roberts gives a list of several nebulæ which have not found a place in catalogues, but which have been recorded on the plates used in his photographic survey. These photographs were taken with his fine 20-inch reflector at Crowborough, and a comparison between these and the recorded places of nebulæ in the "New General Catalogue," and the "Index Catalogue," by Dr. Dreyer, has been fruitful of many discoveries. Of the seventeen new nebulæ, we extract the following description of the largest:—

Region of ℌI. 157 Trianguli, N.G.C. 672; Nova, R.A. 1h. 39m. 39s. N.P.D. 63° 22′·3.—It is nearly as large and prominent as ℌI. 157, and distant from centre to centre 8′ only; nucleus consists of six faint stellar condensations forming a straight line in the direction south, following to north preceding, and there are six or seven very faint condensations of nebulosity near the preceding margin; 15th mag. star on the north preceding margin, and a 16th mag. star at the south following end of the nucleus, 1896 November 29.

It is remarkable that this object should have escaped detection by the many keen-eyed observers who have examined the nebula ℌI. 157, which is only four minutes of arc distance from it; and it appears to me that we are justified by the evidence in inferring that this nebula has come into the state of visibility during the past half-century. Lord Rosse, in 1896, made several observations of the nebula adjoining, but does not refer to this one. It is remarkable also that the nuclei of the two nebulæ are straight lines of faint nebulous stars immersed in nebulosity, and they are so clearly depicted on the photograph that I think they should be visible to the eye by the aid of telescopic power.

Dr. Roberts finds further, by examining his negatives, that two classes of stars, which he terms "faint" and "small," attract notice. The former have small bright nuclei surrounded by nebulosity, and are quite distinct from the latter, which appear as small round spots without a nucleus. These, he states, would, if they were classified, come under the heading, "small circular nebulæ with small bright stellar nuclei."

HARVARD COLLEGE OBSERVATORY ZONE OBSERVATIONS.—Volume xxxvi. of the *Annals* of the Astronomical Observatory of Harvard College contains the journal of the zone observations of stars between 49° 50′ and 55° 10′ of North Declination. These observations were made with the meridian circle during the ten years 1875 to 1885 by Mr. William Rogers, under the direction of the successive directors Joseph Winlock and E. C. Pickering. The present volume completes the journal begun in volume xxxv., and in this review all doubtful cases have been re-examined.

THE ROYAL OBSERVATORY, GREENWICH.

THE Astronomer Royal presented his annual report on Saturday last to the Board of Visitors of the Royal Observatory, Greenwich. Among the numerous guests were many astronomers and men of science, who inspected the buildings and instruments, especially those which have been erected since the visitation last year, namely, the Thompson equatorial and the new altazimuth. The following extracts from the report contain a brief *résumé* of the year's work.

Buildings.

The building of the north wing and central dome of the Physical Observatory was finished in September 1896, with the exception of the vane on the central dome, which was completed last March.

An observing floor and gallery have quite recently been fitted up in the dome to facilitate work with the new Thompson equatorial, now mounted there. The completion of the Physical Observatory by the building of the east and west wings has been further delayed, though provision was made for commencing the work in the last financial year.

The Transit Circle.

With regard to this instrument, it has been found that the apparent correction for discordance between the nadir observations and stars observed by reflexion has been gradually increasing yearly, the difference for the present year being −0″·44, the greatest negative value recorded since 1888.

The increase in this discordance in 1896, following on the systematically negative values since 1891, led to a re-examination of the screws of the microscope-micrometers, of the screw of the telescope-micrometer, and of the errors of those divisions of the circle which are used in observations of the nadir, with a view to the discovery of the source of this discordance.

The microscope-micrometers showed signs of wear, but the reversal of three of the screws has successfully eliminated the effect of wear from the mean of the six microscopes.

The New Altazimuth.

This instrument was erected in May 1896, but it was not practicable to make observations with it till the completion of the observing floor in September. It was then found that there were serious discordances in the readings of the circles under the different microscopes, depending on the direction in which the instrument was last turned. Experiments indicated flexure in the axis, which has now been corrected by stiffening the axis by means of a strong diaphragm of special form fitted in the central part of the axis. The friction-rollers for taking the weight of the instrument have also been modified, the position being changed to bring them close to the pivots, and a system of levers has been substituted for springs. These changes reduced the discordances greatly in amount. Quite recently Mr. Simms has discovered a cause of error, arising from a tendency in the pivots to act as a screw, a longitudinal force being thus introduced, its direction depending on the direction in which the telescope is turned. This force had the effect of slightly moving the iron standards carrying the bearings and the microscopes, thus changing the position of the microscopes relatively to the graduated circles. This action of the pivots was found to arise from the method adopted in grinding them of giving a helical twist to the grinder, and it was cured by a few circular turns of the same tool.

The Thompson Equatorial.

This new instrument, presented by Sir Henry Thompson, forms a handsome addition to the Observatory, and it has been mounted in the Physical Observatory under the Lassell Dome. Its erection there was commenced early in November, but it was not ready for use till April, and there are still certain accessories which have to be supplied. The adjustment of the polar axis and of the 26-inch object-glass were at once taken in

hand, and the former was soon satisfactorily effected. For the adjustment of the object-glass a number of photographs have been taken inside and outside of the focus, the separation between the lenses being varied with a view to the correction of the small outstanding aberration and coma. Some photographs of the moon and of double stars have been taken, an enlarging camera with a Dallmeyer concave magnifier being applied to the telescope in some cases to give a magnified image. This equatorial carries not only the 26-inch photographic telescope with the 12¾-inch Merz guiding telescope and the Thompson 9-inch photoheliograph, but also a Cassegrain reflecting telescope of 30 inches aperture with the 6-inch Hodgson telescope as guider in place of the counterpoise at the other end of the declination axis. It thus provides a very powerful combination of telescopes specially adapted to photographic work of various kinds, and special arrangements in the instrument and observing room have been necessary to meet the varied requirements. The instrument has now been got into good working order, and is very satisfactory as regards the mechanical arrangements. The photographic spectroscope will be used in connection with the Cassegrain reflector mounted firmly at the back of the cell of the mirror, a diagonal prism being used to reflect the rays into the collimator.

The 28-inch Refractor.

This instrument was in constant use for micrometric measurements from 1896 May 11, to 1897 January 11. On January 12 the crown lens was reversed, and the instrument used for photography till April 23, except on the occasion of Prof. Barnard's visit to the Observatory, when the lens was replaced in the visual position. Besides several micrometric observations, 195 double stars were measured during the year ending May 10. The distance and position-angle of the satellite of Neptune were measured on four nights, and the equatorial and polar diameters on two nights. The equatorial and polar diameters of Mars were measured on seven nights. With the crown lens in the reversed position, a number of photographs was taken in and out of focus for the better adjustment of the separation of the lenses and the tilt.

The Astrophysical Equatorial.

The following statement shows the progress made with the photo-mapping of the heavens :—

	For the Chart (exposure 40m.).		For the Catalogue (exposures 6m., 3m. and 20s.).
Number of photographs taken	175	...	139
,, successful plates ...	135	...	110
,, fields photographed successfully...	133	...	98
Total number of successful fields reported 1896, May 10 ...	490	...	732
Number of photographs, previously considered successful, rejected during year ...	72	...	16
Total number of successful fields obtained to 1897 May 10 ...	551	...	814
Number still to be taken ...	598	...	335

Of the fields still required 197 are within 10° of the Pole, and no photographs of this part of the sky have yet been taken, the work being purposely deferred till near the epoch 1900.

Spectroscopic and Heliographic Observations.

Photographs of the sun were taken on 222 days, and of these 471 have been selected for preservation, besides twelve photographs with double images of the sun for determination of zero of position-angle.

For the preceding year Greenwich photographs were selected for measurement on 206 days, and photographs from the Solar Physics Committee (filling up the gaps in the series) on 154 days, making a total of 360 days out of 366 on which photographs are available.

The spot activity of the sun has continued on the whole to decline since the date of the last Report, but has undergone two remarkable cases of temporary revival; the one in September 1896, when the longest connected group ever photographed at Greenwich was observed, and the other at the commencement of the present year. On the other hand, the sun was seen to be free from spots on six days in the year ending 1897 May 10.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents have been registered photographically, and acccompanying eye observations of absolute declination, horizontal force and dip have been made as in former years.

The principal results for the magnetic elements for 1896 are as follows :—

Mean declination ...	16° 56'·5 West.
Mean horizontal force	3·9834 (in British units). 1·8367 (in metric units).
Mean dip	67° 8'·5 (by 9-inch needles). 67° 9'·3 (by 6-inch needles). 67° 10'·0 (by 3-inch needles).

These results are to a certain extent affected by the iron in the new Physical Observatory, and in the new Altazimuth Pavilion.

The selection of the site for the new Magnetic Pavilion required much consideration and necessitated observations at a number of stations in Greenwich Park. As the result of the survey it was decided to abandon a site which had been provisionally selected at a distance of about 250 feet to the east of the reservoir, and to choose another at a considerably greater distance both from the reservoir and the Observatory.

Meteorological Observations.

The mean temperature of the year 1896 was 50°·1, being 0°·7 above the average for the fifty years 1841–1890.

During the twelve months ending 1897 April 30, the highest daily temperature in the shade recorded on the open stand was 91°·1 on July 14. The highest reading recorded in the Stevenson screen was 87°·6. Under the same conditions of exposure on the open stand there have been twenty-six instances of temperatures exceeding 90° recorded in the preceding fifty-five years, the highest having been 97°·1 on 1881 July 15. The temperature rose twice above 90° in 1896, and seventeen times above 80°. The monthly mean temperatures for June, July, February and March were respectively above the corresponding averages by 4°·0, 2°·8, 3°·5 and 3°·3 ; and the means for August, October, November and January were in defect by 2°·5, 3°·5, 2°·7 and 3°·1. The mean temperature for the twelve months 1896 May to 1897 April was 49°·7, being 0°·2 above the fifty years' average.

In the winter months of 1896–1897 there were forty-two days on which the temperature of the air fell to the freezing-point, or below ; sixteen of these days occurring in January, and eleven in December. The lowest winter temperature was 23°·8 on 1897 January 18, as compared with 24°·3 in the preceding winter.

The number of hours of bright sunshine recorded during the twelve months ending 1897 April 30 by the Campbell-Stokes instrument (with the old ball up to December 31, and with the new ball after), was 1152 out of the 4454 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·259, constant sunshine being represented by 1. This amount is probably too small for reasons stated in the report.

The rainfall for the year ending 1897 April 30 was 26·83 inches, being 2·29 inches above the fifty years' average. The number of rainy days in the twelve months was 178.

Personal Establishment.

In the last Report mention was made regarding the reorganisation of the staff. The arrangement now adopted is that Mr. Dyson and Mr. Cowell have the general superintendence of all the work of the Observatory, Mr. Dyson taking special charge of the astronomical department, and Mr. Cowell of the astrophysical department, in which is included the magnetic and meteorological branch. Mr. Maunder is charged with the heliographic photography and reductions. Mr. Lewis has charge of the time-signals and chronometers, and of the 28-inch equatorial. Mr. Thackeray superintends the miscellaneous astronomical computations and meridian zenith-distance reductions. Mr. Hollis has charge of the photographic mapping of the heavens, the measurement of the plates, and the computations for the astrographic catalogue. Mr. Crommelin undertakes the altazimuth and Sheepshanks equatorial reductions, and Mr. Bryant the transit-reductions and time-determinations. In the magnetic and meteorological branch, Mr. Nash has the charge of the whole of the work.

INSECTS AFFECTING DOMESTIC ANIMALS.[1]

THIS work is one of the most recent of the many valuable publications on economic entomology for which we are indebted to the Department of Agriculture of the United States, and is a well-printed and well-illustrated volume of about 300 pages, giving, firstly, an enormous amount of useful information on the histories and means of prevention of insects injurious to wild and domesticated animals, and also to man. Following on this are about sixty pages devoted to the wingless parasites, classed scientifically in the sub-order *Mallophaga* more shortly here as "biting lice"; and a further division, of about twenty-five pages, gives under the heading of *Arachnida* some of the most important representatives of the "mites, ticks, scab insects, mange insects, &c."

The value of the book is much enhanced by the excellent supply given of explanatory adjuncts, including in these a very full table of contents, with number of page bracketed to name of each insect or parasite; also an introduction dealing mainly with points of entomological classification, distribution of the pests, as to the divisions of mammals, birds, &c., affected by them, and "Effects of Parasites on the Host, &c."

The body of the book is followed by "A List of Parasites according to Hosts"; several pages with titles of works more especially bearing on the infestations previously entered on, together with the names of their authors, and a good index completes the useful volume.

In the "letter of transmittal" of the work to the U.S. Secretary of Agriculture, it is noted by Dr. L. O. Howard, Entomologist to the Department, that "the Report will form an excellent text-book of the subject, and is a work which in the opinion of the writer should be in the hands of all stock raisers." This, of course, refers primarily to stock raisers of the United States; but even on our side the Atlantic, from the plainness of the descriptions, both of infestations and remedies, the information will be of much practical use, and also as a scientific as well as practical manual should be in the hands of all our economic entomologists.

The book may be considered as in some degree a legacy, or posthumous contribution by the late Prof. Riley to the work of economic entomology, which he had so much at heart, as we are told in the "Prefatory Note" that the report was originally planned in 1885 as a conjoint work with Dr. C. V. Riley, and it is matter of congratulation that the plans have fallen in their completion into such very well-qualified hands as those of Prof. Osborn.

The accounts of the infestations consist, for the most part, of plainly-worded descriptions of the insects (suitable for general

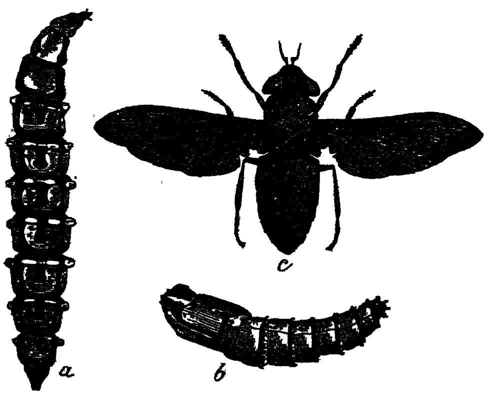


FIG. 1.—*T. atratus*.

use), with notes of habits, distribution, or other points of interest, and measures of prevention and remedy. The figures are clear and good, and that at p. 61, of "The Black Gad Fly" (*Tabanus atratus*), after Prof. Riley, gives a good example of method of representation of the insect in all its stages (Fig. 1). The figure at p. 118, of a cow's horn with the base covered with the clustering masses of the "horn fly" (*Hæmatobia serrata*), gives a guide to the appearance of the infestation *in situ*, unmistakable by the most superficial observer (Fig. 2). A single extract from

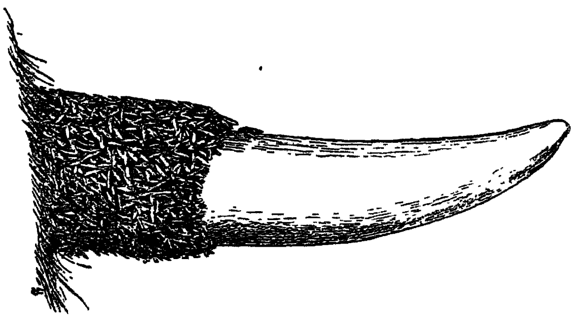


FIG. 2.—Infested cow's horn.

the table of contents may serve as a specimen of the completeness with which the work is given.

"Family SIMULIIDÆ (black flies, buffalo gnats). Losses from buffalo gnats (p. 32)—Life-history and habits (p. 33)—Preventives (p. 36)—Remedies for the bites (p. 37)—Natural enemies of buffalo gnats (p. 38)—Descriptions of species with notes on their habits (p. 38)—The Columbacz midge (p. 38)—*Simulium ornatum* (p. 39)—The black fly (p. 40)—The Southern buffalo gnat (p. 41)—The Turkey gnat (p. 52)—The Western buffalo gnat (p. 55)—*Simulium piscicidium* (p. 56)—*Simulium canescens* (p. 57)—*Simulium rivulara* (p. 57—*Simulium* sp., in Brazil (p. 57)—*Simulium venustum* (p. 57)—*Simulium* sp., near Washington (p. 58)—*Simulium pictipes* (p. 58)."

E. A. O.

[1] "Insects affecting Domestic Animals: an Account of the Species of Importance in North America." By Herbert Osborn, Professor of Zoology and Entomology, Iowa Agricultural College, Ames, Iowa. Bulletin No. 5, New Series, U.S. Department of Agriculture, Div. of Entomology. (Washington: Government Printing Office, 1896.)

THE ENGWURRA, OR FIRE CEREMONY OF CERTAIN CENTRAL AUSTRALIAN TRIBES.[1]

AMONGST certain tribes inhabiting the centre of Australia, the last of the initiation ceremonies through which every man must pass before he is fully admitted to all the sacred mysteries of the tribe, takes the form of a series of what may be called ordeals by fire. Some such ceremony is known to us to exist amongst the Urabunna tribe, in the neighbourhood of Lake Eyre; in the Arunta tribe, which extends across the centre of the continent to about seventy miles north of the Macdonnell Range; and also in the Ilparra and Warramunga tribes, who extend at least two hundred miles still further to the north.

We cannot fully translate the term Engwurra, or Urrumpulla, by which the rite is known in certain parts, but each of them is formed in part of the word *ūrra*, which means fire. The Arunta natives say that the ceremony has the effect of strengthening all those who pass through it. It imparts courage and wisdom, makes the men more kindly-natured, and less apt to quarrel; in short, it makes them *ertwa mūrra oknirra*, words which respectively mean, in the Arunta tongue, "men, good, very, or great."

Evidently the main objects of it are, firstly, to bring the younger men under the control of the elders, whose commands they have implicitly to obey; secondly, to teach them habits of self-restraint and hardihood; and thirdly, to show to the younger men who have arrived at mature age, the sacred secrets of the tribe, especially those which are associated with the totems.

The Engwurra is the fourth of the initiatory rites through which every Arunta native has to pass. Of two of the three earlier ones the details have already been described by one of us,[2] and, stated briefly, the ceremonies are as follows. At the age of about ten or twelve the boys are taken to a spot close to the main camp, where the men and women assemble. Whilst

[1] The paper, of which this is an outline, was read before the Royal Society of Victoria, in April, by Prof. Baldwin Spencer and F. J. Gillen, Sub-Protector of Aborigines, Alice Springs, South Australia.

[2] F. J. Gillen, in "Report on the Work of the Horn Exped. to Cent. Aust." Part iv., "Anthropology," p. 169. Plates 16, 17, 18.

the women dance round, the men toss the boys in the air and catch them as they fall.

This over, they are painted on the back and chest with straight or curved bands outlined by red or yellow ochre lines, the painting being done by a man who stands in the relationship to the boy of brother to a woman whom it will afterwards be lawful for him to take as wife. The boy is told that this ceremony will promote his growth, and that the time has now come when he must no longer play with, and live at the camp of, the women and children, but must go to that of the unmarried men, and live with them. He begins to accompany the men in their hunting expeditions, listens to their talks around the camp fire at night, and looks forward to the time when he shall be admitted to the privilege of manhood.

Some years elapse before the second ceremony is performed. When he arrives at puberty, or possibly not till some time later, the rite of circumcision is practised; and a short time after this, there follows the third rite—that of sub-incision. When he has passed through these three ceremonies, the native is admitted to the ranks of the men; he may wear a hair girdle round his waist, tie his hair back with the forehead-band, and may take a wife.

The different periods of his life are indicated by different terms. When a mere child, he is Amba-querka; after having been thrown up, he is Ulpmerka; after circumcision, he is Arrakurta; after sub-incision, he is Ertwa-kurka; and finally, when he has passed through the Engwurra, he becomes an Urliara.

The Engwurra ceremony, which the authors witnessed, was held amongst the Macdonnell Ranges, in the vicinity of Alice Springs telegraph station on the overland telegraph line between Adelaide and Port Darwin. Of this station one of the authors is officer in charge; and his long acquaintance with the natives, as well as the fact that he is Sub-Protector of the Aborigines, has given him special facilities for gaining their confidence.

The ceremony lasted four months, commencing in September 1896, and ending in January 1897; and during this period the authors spent the greater part of the time in the native camp, being allowed to witness everything which took place—being, in fact, regarded as members of the tribe.

The spot chosen for the ceremony was a level stretch of ground, hemmed in on one side by a range of rugged quartzite, and on the other by the River Todd, which, like all other Central Australian rivers, is, except at rare intervals, a dry tract of sand bordered by steep banks on which grows a fringe of gum-trees and low scrub. This level flat formed the Mirra Engwurra, or Engwurra Camp. The women's camp was out of sight on the other side of the river; for, needless to say, the women and uninitiated were not allowed to go anywhere near to the sacred ground.

The natives are summoned to the Engwurra by messengers sent out by the old man who presides at the ceremony. There may be one or more messengers, and each carries one or two of the sacred sticks or Churinga wrapped up from sight in emu feathers, the Churinga being of the nature of the objects commonly called bull-roarers. The messenger who summons to the Engwurra is called *Ilchinkinja*, the word being a compound of *ilcha*, hand, and *inkinja*, to lift up, and may be translated by the term "the beckoning hand." The significance of the Churinga will be seen shortly; meanwhile it may be said that in their natural state no native dare disobey such a summons, through fear of the harmful consequences which would befall him if he did so.

Representatives of the different local groups of the Arunta tribe assembled early in September, each group bringing with it stores of its sacred Churinga, which were under the careful charge of the elder men.

Before going further, it is necessary to allude briefly to the organisation of the tribe. Its division into exogamously intermarrying phratries or classes has been already clearly shown by Messrs. Howitt and Fison, and later by Messrs. Gillen and Stirling. There is little doubt but that originally there were two main phratries, each of which became divided again into two, whilst at the present day the division has been, or rather is now being, carried still further, with the result that instead of four, we have eight sub-phratries. This division into eight exists in reality throughout the tribe; but it is only amongst the northern groups that there are separate names for each of them, and it will be simpler here to deal with the four which are found throughout the tribe. The names of these four are Panunga, Bultharra, Purula and Kumarra. One moiety of the tribe consists of the first two, the other of the second two. The marriage arrangements are as follows:—

Bultharra (male)	marries	Kumarra,	children are	Panunga.
Panunga	,,	Purula,	,,	Bultharra.
Purula	,,	Panunga,	,,	Kumarra.
Kumarra	,,	Bultharra,	,,	Purula.

Every Bultharra man, for example, must marry a Kumarra woman, that is, one who comes from the moiety of the tribe to which he does not belong, and their children, go into the man's moiety, but into the sub-phratry to which he did not belong. At the same time the Kumarra women are divided into two sets, owing to the social organisation—details of which will subsequently be published by the authors—and these two sets stand respectively to each individual Bultharra man in the relationship of what is called Unawa and Unkulla, and it is only the former who are eligible to him as wives. In just the same way the Bultharra men are divided into two sets, who stand respectively to any Kumarra woman in the relationship of Unawa, whom she may marry, and Unkulla, whom she may not.

There can be no doubt whatever about the fact that the Panunga and Bultharra form one moiety, and the Kumarra and Purula another. This is shown in various ways, and when large numbers of the natives are gathered together at such a ceremony as the Engwurra, it stands out most clearly. Not only are there two main camps on the Engwurra ground, at one of which the Panunga and Bultharra gather, and at the other the Purula and Kumarra, but the sacred Churinga are deposited in two separate spots, those of the Panunga and Bultharra being placed, during the Engwurra which the authors witnessed, on a platform erected in a Mulga tree on the hill-side, overlooking at one end the ceremony ground, whilst those of the Kumarra and Purula were placed on a small platform at the opposite end.

As soon as the natives had begun to assemble, the Alice Springs blacks, in whose locality the ceremony was to be performed, opened the proceedings by performing two corrobborees, or ordinary dancing festivals, which occupied the evenings of the first three weeks, and at which, as they are not sacred, the women are allowed to be present, and to take part.

Before these were finished, the old man presiding over the Engwurra went to the chosen ground, and there raised a small mound of earth about forty feet long, one foot high, and two feet across, planting all along it small boughs of Eucalyptus. This mound is called the Parra, and apparently represents a tract of country. When this was done, the older men, who had already passed through the ceremony, and had thus become Urliara, together with the younger men, about forty in number, and varying in age from twenty to thirty-five, or even forty, who were to be made Urliara, spent the whole time during the ensuing two and a half months in the performance of sacred ceremonies on the Engwurra ground. Every day a certain number of young men are sent out to hunt for game, but from this time forward until the end of the whole ceremony they are not supposed to go near the women's camps. They must sleep at night on the Engwurra ground, and are completely under the control of the older men, whose orders they must implicitly obey.

The sacred[1] ceremonies, of which the authors witnessed the performance of about sixty, were all concerned with the numerous totems into which the members of the tribe are divided, and the special object of the authors was to gain an insight into the totemic system, and in connection with this to arrive, if possible, at a correct knowledge of the significance of the Churinga. These Churinga, or sacred sticks and stones,[2] are the most valuable possession of the Arunta natives, and throughout the tribe they are stored in considerable numbers in special hiding-places, the exact locality of which is only supposed to be known to the older men of each local group in whose district they are preserved. The whole tribe is divided up into a large number of such local groups, who reside in and are regarded as the proprietors of a definite tract of land, and each of the latter is especially associated with the name of some object, which is usually that of an animal or plant, and is, in fact, the totem of

[1] The term sacred is used to distinguish them from the ordinary ones, such as the dancing festivals, commonly called corrobborees, which any one, women and children included, may witness, whilst the sacred ones may only be seen by initiated men.

[2] Remarks upon and drawings of some of these will be found in the work by Messrs. Gillen and Stirling, previously alluded to. Therein Mr. Gillen supplied the information that they were symbolic of the totems, which may be modified now by saying that each Churinga is symbolic of an individual belonging to a particular totem.

the majority of individuals who occupy that particular area. The whole country occupied by the Arunta—and the same is true of other tribes of which the authors have information—is divided up into a large number of parts, each comprising what the natives call an *Oknannikilla*, which may be described as a local totem centre. There are, for example, certain areas forming wild cat oknannikillas, others emu, kangaroo, mulga, frog, and so on, the exact position of which is known to the natives.

If, on the other hand, we examine the Urabunna tribe, which adjoins the Arunta on the south, we see clearly a fundamental difference in regard to the totemic system. The Urabunna are divided into two phratries, viz. Matthurrie and Kirarawa, and each of these again into certain totems, the same totem not occurring in both phratries. The organisation of the tribe is such that a Matthurrie man must marry a Kirarawa woman, and not only this, but there is the further restriction that a man of one totem must marry a woman of another. Thus a Matthurrie cricket man must marry a Kirarawa crow woman, and, as descent is counted through the mother, and not, as in the Arunta, through the father, the children are Kirarawa and crows.

In the Arunta it is quite different, and so far as the totems are concerned, at first sight most perplexing. The subphratry name is simple, every child of a Bultharra man and a Purula woman is a Panunga, and so forth, but there is no such orderly method in the totem names. The following actual examples of three, amongst many families investigated by the authors, are typical of what is found through the tribe.

In the first family the father is Hawk; wife No. 1, Bandicoot; daughter, Witchetty Grub; wife No. 2, Kangaroo; no children; wife No. 3, Lizard; two daughters, one Emu, the other Water.

In the second family the father is Witchetty Grub; wife No. 1, Lizard; no children; wife No. 2, Munyeru (grass seed); two daughters, one Lizard, the other Witchetty Grub.

In the third family the father is Eaglehawk; wife No. 1, Hakea flower; no children; wife No. 2, Hakea flower; three sons, respectively Witchetty Grub, Emu, Eaglehawk; two daughters, each Witchetty Grub.

Two things are clear, first, that the totems, as they now exist, have nothing to do with regulating marriage; and second, that the totems of the children do not of necessity follow either that of father or mother; they may be identical with either or both of them, or they may be entirely different.

It was whilst watching the ceremonies during the Engwurra, and questioning carefully the performers after each one was concluded, that the authors were able to gather information explaining this apparently perplexing system, and also to arrive at an understanding of the significance of the Churinga. The information derived is briefly as follows.

Each ceremony was connected with some particular totem and, further, with some special locality, and each one dealt with some particular ancestral individual or individuals. The traditions of the tribe refer back to a long past time called the Alcheringa (which means dream-times), when their ancestors were designated by the name of, usually, some animal or plant. Thus we have a group of individuals living in the Alcheringa, of whom it is difficult to say whether they were men-kangaroos or kangaroo-men, the identity of the human individual being sunk in that of the object with which he is associated, whose name he bears, and from whom he sprung. These kangaroo-men walked about the country now inhabited by the tribe, following a definite route and halting at certain places, the positions of which are well known to the natives by means of the traditions which have been handed down from generation to generation. In a similar way groups of Emu, Frog, Mulga, Wild Cat, and other individuals walked across the country.

Each one of these Alcheringa ancestors carried with him or her a number of sacred Churinga, and where they halted, there an oknannikilla or local totem centre was formed. At each spot, so says tradition, certain individuals went into the ground, and each became a Churinga, which is associated with the spirit part of the individual. Not only this, but at each such spot they deposited a large number of the Churinga which they carried, and with each one of which in the same way a spirit individual was associated.

Then the whole area now occupied by the tribe became, as it were, dotted over with a large number of local totem centres, and this idea of spirit individuals of definite totems, associated with Churinga and resident in certain spots, lies at the root of the present totemic system of the Arunta and other tribes of Central Australia.

Thus we have close to Alice Springs a large and important Witchetty Grub totem centre, and the following will serve as a typical example of how each man and woman gain a totem name. There were deposited in the Alcheringa, close by Alice Springs, a large number of Witchetty Churinga, each of course associated with a spirit individual. The latter can move about, and always carries with it its Churinga, and is supposed to frequent some special tree or stone, which is called its *Nanja* tree or stone. When a woman conceives, it is one of these spirit individuals who has entered her body, and therefore, quite irrespective of what the father or mother's totem may be, the child when born must of necessity belong to the spot at which it was conceived, or rather at which the mother believes that it was. Recently, for example, an Emu woman from another locality came on a visit to Alice Springs. There she conceived a child, but returned to her own Emu locality before that child was born. When born, that child was a Witchetty Grub—it must be, the natives say, because it entered the mother's body at Alice Springs, which is a Witchetty totem centre; it is, in fact, nothing more nor less than the reincarnation of an Alcheringa Witchetty Grub. Had it entered the mother within the limits of her own Emu locality, it would as inevitably have been born an Emu

Further, when the spirit-child enters the mother, it drops its Churinga. After it is born the mother tells the father exactly where it was conceived—that is, the spot where she first became aware that she had conceived a child—and the father and one or two other men go there, and either search until they find the Churinga, or if they do not find one, then they make one out of the mulga or other hard wood tree which lies nearest to the Nanja tree, carve on it the design of the child's totem, and hand it over for safe keeping to the head man of that locality, who places it in the sacred storehouse where all the Churinga of that totem centre are preserved. This Churinga becomes the Churinga Nanja of the child.

The meaning and importance of the Churinga may be gathered from the above sketch, from which many details, to be published later, are of necessity omitted.

It is during the Engwurra, and whilst the ceremonies concerned with the totems are being performed, that the old men of the tribe show the Churinga to the younger men, telling them to whom they have belonged and the traditions associated with them, and thus ensure the passing on of this knowledge from generation to generation; in fact, in ceremonies such as these we see the earliest beginnings of historical records.

Whilst the Engwurra is largely concerned with the performance of the sacred ceremonies, an equally important part is played by the fire ordeals from which the name is derived, and to which reference must now be briefly made. A full description of these, together with illustrations from photographs taken by the authors, will be published as soon as possible.

During the last month of the time occupied by the performance of the Engwurra the young men, who are being made Urliara, are taken out into the bush every day before sunrise, under the charge of certain elder men. There they have to remain all day hunting game, which must be brought in to the elder men, who stay in camp performing ceremonies. The young men are not supposed to eat much, and become poorer and poorer as the weeks pass by. Usually, but not always, they are brought back to the Engwurra ground by way of the women's camp. Just before sunset the women—Bultharra and Panunga in one spot, and Purula and Kumarra in another, some little distance apart—make a fire of bushes, and, standing behind this, move their hands as if inviting the young men, who are now called Illpongwurra, to approach. This they do, holding shields and boughs of a particular shrub over their heads. Then the lubras or women, carrying burning grass and boughs, run towards them, and throw the burning material over their heads. The men have to protect themselves with shields as well as they can, and after going to each fire they turn tail, followed by the women, who stop and run back again when they reach the bed of the river, on the other side of which lies the Engwurra ground, which they must not approach. Arrived at the latter, the young men lie down in a long row, each man having his head upon the Parra. Perfect silence is maintained, and here they must remain until the old men give them permission to arise. Each old man takes charge of four or five young men, who become what is called *apmūrra* to him and he to them, and no young man may speak to, or in the presence of, his apmūrra till all is over.

Within the last week of the ceremony the young men have to undergo another and more severe ordeal. In a secluded spot amongst the hills the old men, who have gone out in charge of them, make a large fire of logs. When these have burned down, and the red-hot ashes remain, green boughs of Eucalyptus are thrown on the fire, and on these the young men have to lie down in the heat and stifling smoke until they receive permission from the old men to get up.

Finally, on the last night the men all congregate around a sacred pole which has been erected close by the Parra, and here, all night long, the old men decorate the backs and chests of the younger men with designs, often very elaborate and distinctive, of the various totems. A man is not of necessity—in fact, very seldom is—painted with the design of his own totem. All night long the women remain awake and active in their camp across the river, where again they make two fires in shallow pits, but this time closely side by side.

Before sunrise the decorated men gather together at the base of the sacred pole, the head man of the ceremony breaks through the Parra mound, and across the opening thus formed the old men lead their charges, all walking in single file and holding one another's hands. In perfect silence the string of painted men pass from the Engwurra ground across the bed of the creek, and so on to the women's camp, where they form a group, and halt some fifty yards away from the women, who stand behind their fires, which are now giving off dense clouds of smoke from green gum boughs.

Then each old man takes the younger ones under his charge, and with them runs up to the fires. The Bultharra and Panunga men go to the fire made by the Purula and Kumarra women, and *vice versâ*, kneeling upon it while the women press them down with their hands upon the men's shoulders. When all have been upon the fires, the old men and the newly-made Urliara cross the river-bed again to the Engwurra ground, and sit around the sacred pole. The fire ceremonies are now complete, but as yet the younger men may not speak to their apmūrra, but must remain out in the bush. After a length of time, varying from two weeks to perhaps six months, each young man brings in a present of food called Chowarilya to his apmūrra man, when a sacred ceremony is performed, at the close of which the mouths of the old and young men who are present are touched either with the food brought in, or with some object which has been used in the ceremony, and the ban of silence is removed.

PROFESSOR NEWCOMB ON THE DISTANCES OF THE STARS.[1]

THE problem of the distances of the stars is of peculiar interest in connection with the Copernican system. The greatest objection to this system, which must have been more clearly seen by astronomers themselves than by any others, was found in the absence of any apparent parallax of the stars. If the earth performed such an immeasurable circle around the sun as Copernicus maintained, then, as it passed from side to side of its orbit, the stars outside the solar system must appear to have a corresponding motion in the other direction, and thus to swing back and forth as the earth moved in one and the other direction. The fact that not the slightest swing of that sort could be seen was, from the time of Ptolemy, the basis on which the doctrine of the earth's immobility rested. The difficulty was simply ignored by Copernicus and his immediate successors.

An indication of the extent to which the difficulty thus arising was felt is seen in the title of a book published by Horrebow, the Danish astronomer, some two centuries ago. This industrious observer, one of the first who used an instrument resembling our meridian transit of the present day, determined to see if he could find the parallax of the stars by observing the intervals at which a pair of stars in opposite quarters of the heavens crossed his meridian at opposite seasons of the year. When, as he thought, he had won success, he published his observations and conclusions under the title of "Copernicus Triumphans." But, alas! the keen criticism of his contemporaries showed that what he supposed to be a swing of the stars from season to season arose from a minute variation in the rate of his clock, due to the different temperatures to which it was exposed during the day and the night. The measurement of the distance even of the nearest stars evaded astronomical research, until Bessel and Struve arose in the early part of the present century.

On some aspects of the problem of the extent of the universe light is being thrown even now. Evidence is gradually accumulating which points to the probability that the successive orders of smaller and smaller stars, which our continually increasing telescopic power brings into view, are not situated at greater and greater distances, but that we actually see the boundary of our universe. This indication lends a peculiar interest to various questions growing out of the motions of the stars. Quite possibly the problem of these motions will be the great one of the future astronomer. Even now it suggests thoughts and questions of the most far-reaching character.

I have seldom felt a more delicious sense of repose than when crossing the ocean during the summer months I sought a place where I could lie alone on the deck, look up at the constellations, with *Lyra* near the zenith, and, while listening to the clank of the engine, try to calculate the hundreds of millions of years which would be required by our ship to reach the star α Lyræ if she could continue her course in that direction without ever stopping. It is a striking example of how easily we may fail to realise our knowledge when I say that I have thought many a time how deliciously one might pass those hundred millions of years in a journey to the star α Lyræ, without its occurring to me that we are actually making that very journey at a speed compared with which the motion of a steamship is slow indeed. Through every year, every hour, every minute, of human history from the first appearance of man on the earth, from the era of the builders of the Pyramids, through the times of Cæsar and Hannibal, through the period of every event that history records, not merely our earth, but the sun and the whole solar system with it, have been speeding their way towards the star of which I speak on a journey of which we know neither the beginning nor the end. During every clock-beat through which humanity has existed it has moved on this journey by an amount which we cannot specify more exactly than to say that it is probably between five and nine miles per second. We are at this moment thousands of miles nearer to α Lyræ than we were a few minutes ago when I began this discourse, and through every future moment, for untold thousands of years to come, the earth and all there is on it will be nearer to α Lyræ, or nearer to the place where that star now is, by hundreds of miles for every minute of time come and gone. When shall we get there? Probably in less than a million years, perhaps in half a million. We cannot tell exactly, but get there we must if the laws of nature and the laws of motion continue as they are. To attain to the stars was the seemingly vain wish of the philosopher, but the whole human race is, in a certain sense, realising this wish as rapidly as a speed of six or eight miles a second can bring it about.

I have called attention to this motion because it may, in the not distant future, afford the means of approximating to a solution of the problem already mentioned, that of the extent of the universe. Notwithstanding the success of astronomers during the present century in measuring the parallax of a number of stars, the most recent investigations show that there are very few, perhaps hardly more than a score of stars of which the parallax, and therefore the distance, has been determined with any approach to certainty. Many parallaxes, determined by observers about the middle of the century, have had to disappear before the powerful tests applied by measures with the heliometer; others have been greatly reduced, and the distances of the stars increased in proportion. So far as measurement goes, we can only say of the distances of all the stars, except the few whose parallaxes have been determined, that they are immeasurable. The radius of the earth's orbit, a line more than ninety millions of miles in length, not only vanishes from sight before we reach the distance of the great mass of stars, but becomes such a mere point that, when magnified by the powerful instruments of modern times, the most delicate appliances fail to make it measurable. Here the solar motion comes to our help. This motion, by which, as I have said, we are carried unceasingly through space, is made evident by a motion of most of the stars in the opposite direction, just as, passing through a country on a railway, we see the houses on the right and on the left being left behind us. It is clear enough that the apparent motion will be more rapid the nearer the object. We may, therefore, form some idea of the distance of the stars when we know the amount of the motion. It is found

[1] Extracted from an address given by Prof. Simon Newcomb at the dedication of the Flower Observatory, University of Pennsylvania, May 12.

that, in the great mass of stars of the sixth magnitude, the smallest visible to the naked eye, the motion is about three seconds per century. As a measure thus stated does not convey an accurate conception of magnitude to one not practiced in the subject, I would say that, in the heavens, to the ordinary eye, a pair of stars will appear single unless they are separated by a distance of 150 or 200 seconds. Let us then imagine ourselves looking at a star of the sixth magnitude, which is at rest while we are carried past it with the motion of six or eight miles per second which I have described. Mark its position in the heavens as we see it to-day; then let its position again be marked 5000 years hence. A good eye will just be able to perceive that there are two stars marked instead of one. The two would be so close together that no distinct space between them could be perceived by unaided vision. It is due to the magnifying power of the telescope, enlarging such small apparent distances, that the motion has been determined in so small a period as the 150 years during which accurate observations of the stars have been made.

PRIMITIVE METHODS OF DRILLING.

"A STUDY of the Primitive Methods of Drilling" is the title of a monograph by Mr. J. D. McGuire, in the recently-published Report of the United States National Museum (1894). The paper covers 125 pages of the Report, and is fully illustrated, in addition to which there are numerous references to books of travel among peoples living under the most primitive conditions. The author of the paper verified his opinions during the progress of the work by experiments in a laboratory fitted up for the purpose in the United States National Museum.

The paper discusses the various ways by which holes are bored in material, ranging from the softest to the hardest known, with such implements as were possessed by different peoples throughout the age of stone, and well through that of metal. The implements employed in performing the work were chiefly such as are on deposit in the Museum, the collections of which, especially from the North American tribes of Indians, are very rich. Yet the author has not hesitated, where circumstances warranted, to seek further afield for examples, notably in the concluding portion of the paper, where he describes a heretofore unrecognised drill, which frequently appears on the bases of royal seats among Egyptian antiquities. The act of cutting a hole through stone, or other substance, is shown to be a much simpler process than archæologists have heretofore supposed. The author has shown by specimens, and by quotations, that man, from the first time of which we have evidence of his existence, perforated with apparent ease material, such as shell or bone or ivory, and that to do this required nothing more than a stick or a stone with a little sand.

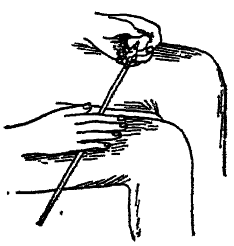


FIG. 1.—Horizontal drilling.

It is shown that early in the Lake period of Switzerland, a hollow cylinder of metal was often employed in boring stone axes, and the same conditions have existed from very early times in the history of the most ancient nations of which we have any records.

The seals of Mesopotamia, as well as the earliest intaglios, it is asserted, were bored with the drill and wheel from a period ante-dating the Christian era by thousands of years. The author shows that the American Indian, at the time of the discovery of the country, employed only the simple shaft-drill revolved between the extended palms of the hands, a method yet in use among the most primitive peoples in producing fire. The same implement, revolved horizontally upon the thigh, is illustrated in Fig. 1, by which means any of the simpler holes found in the earliest antiquities may be readily and quickly reproduced.

The "Bow Drill" (Fig. 2) is represented in the monograph as it has been employed by various races, ancient and modern, showing the manner of working it, and the differences in shape of the bow and shaft of the drill. The author calls attention to Fig. 3, which he says is the drill bow of ancient Egypt carried in sacred processions as an emblem of ceremony.

Fig. 4 is a drill of a complicated character used by certain California tribes, and appears to be an aboriginal American outgrowth of the "Pump Drill," which was imported into the country from Europe or Asia in modern times. The author illustrates what he designates as a "Top Drill" (Fig. 5), worked by means of a single strap and head-piece, which was developed in the course of his experiments. While in itself this drill is not claimed to be of any great value, it did lead to most interesting developments, the principle of which is, among other things, recognised in the Hindu statue of Samudra Mutu (the third incarnation of Vishnu). This again, in its turn, led to the recognition of the "Disc Drill" with double string, shown in Fig. 6, a most common glyph among early and late Egyptian antiquities known as the "S. S. M." or "Sam," which is by some authors thought to be "an altar typical of the Upper and Lower Nile joined under a single Pharaoh." Such a drill was set up in the Museum laboratory, and was found to work with perfect ease, and to be capable of producing any of the holes met with among the bored monumental stones of Egypt. The number of persons who, upon occasion, might be employed at the same time in working this drill, is unlimited; though probably not more than four would be required at any one time.

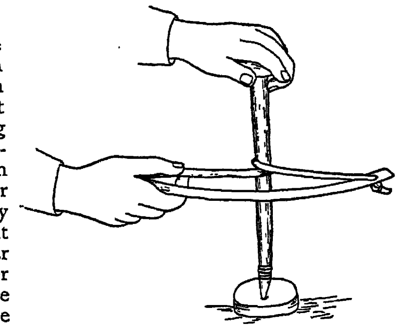


FIG. 2.—Single-handed Bow Drill in use.

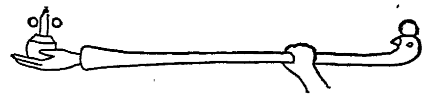


FIG. 3.—Ancient Egyptian Drill Bow.

The author not only tested the different stone points employed in boring stone and softer substances, but used the stone points themselves with sands of differing hardness upon different stones. Metal points to drills, as well as metal cylinders, were tested as to their cutting properties. Points of all kinds were experimented with, demonstrating that the sharp sand and wood points are capable of cutting a hole through any material, provided it was not harder than the sand. The paper shows the different characters of holes met with in objects of a prehistoric period, or by people in a low stage of mechanical development, and describes how such holes were made.

In most instances the exact number of revolutions per minute of each separate drill was recorded, and the character of cutting material was noted; the results were in every instance uniform. The velocity of revolution and hardness of the sand determined with mathematical accuracy the time required to drill a hole through any given material.

The striæ noticed upon the cores left in some holes bored in stone in Egypt had led distinguished Egyptologists to believe that the Egyptians possessed the diamond drill, with diamonds not only set in the lower edge of the cylinder, but on the outer and inner sides as well. Mr. McGuire's experiments have demonstrated that with such a drill as represented in Fig. 6, a hole of almost any diameter may be made through the hardest stone, and that the marks left on the interior of the drill-hole, or exterior of the core in the hole, is governed entirely by the hardness of the sand and size of its grains. The time requisite to perforate any material is shown to be but a fraction of what has been heretofore supposed necessary.

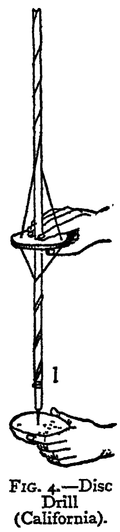


FIG. 4.—Disc Drill (California).

The paper proves the value of a study of the technology of archæology, and its necessity in any intelligent study of primitive implements. The manufacture of any product of ancient man

carries additional information to that which may be gathered merely from the shape of the article. Crushing stone, hammering or breaking it, by heat or cold, by pressure applied in any of the many known ways, each and every item of personal work has its value, and no one can say in advance to what its inspection may lead. We gather here, if the author be correct in his claims, data which no one could have anticipated in advance of experiments.

The long-stone drill points are found unsuited to boring substances which wood and dry sand will cut with ease. Soft wood is shown to be as unsuited as is hard wood for drill shafts. The hard stone point is found to cut steatite or wood quite

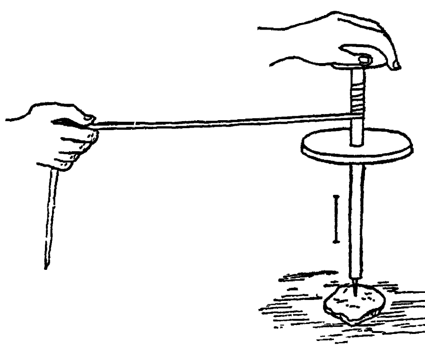


FIG 5.—Top Drill

readily, but is easily broken if it is attempted to bore hard stone with it. The study has been a careful one, has extended over a long period, and no known source of information has been intentionally neglected. Personal acquaintance with drills and their workings, as developed in the paper, is calculated to familiarise one with the Australian or American producing fire with the plain shaft-drill. It enables us to see in a new light Ulysses and his companions boring the eye from the Cyclops king. It gives a new interpretation to one of the incarnations of Vishnu. The remark of the latter, that their foes "should share their toil," suggests further, that instead of the "Nile gods" being

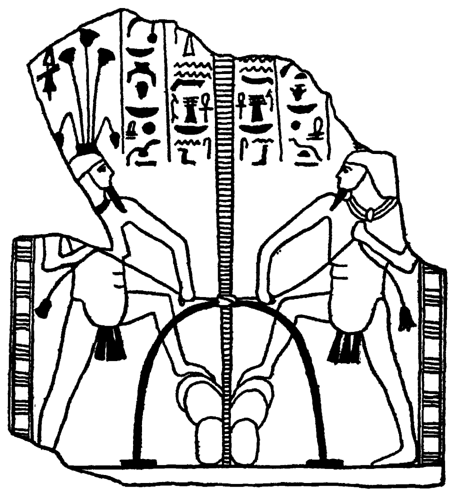


FIG. 6.—Disc Drill on Base of Statue of Amennembat.

shown in Fig. 6, we see the citizens of a subjugated territory performing ordinary menial labour. The so-called "gods" themselves are usually females, Negro or Asiatic, who hold the straps of the drill. It will be interesting to inquire whether under the late Nubian dynasty the Negro disappears from the work, and the Egyptian takes the subordinate place when the latter became subject to the Negro dynasty. The drill represented in the closing pages of the paper is capable of performing more and better work in boring stone than any other known hand-implement, either of ancient or modern date. This drill familiarises us somewhat with the high degree of skill possessed by the Egyptian workman of a remote antiquity. The author, in reproducing the Egyptian drill, has no doubts as to the identity of its shaft, its disc, the straps used to revolve it, or of the principle upon which it worked. He also believes that it was braced in some way. The bracing and method of tightening down the braces, invariably accompanying the drill, and even the possibility of the shafts having been tautened by strings or straps, are matters not satisfactorily interpreted. It will be a matter of interest to have more examples of this implement, which acquaints us with the man of Ancient Egypt in possession of a very complicated machine at a period in the life of the nation centuries prior to any date heretofore suggested. The scarcity of works and photographs on Egypt accessible to the author, prevents the hope that he may further interpret with available material the braces and means of tightening down this drill; but it is suggested that, in Europe and the East, there may be found sufficient data to answer this enigma.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. J. Sollas, F.R.S., has been appointed a delegate to attend the International Geological Congress to be held at St. Petersburg in August or September next.

The following examiners for the Honour School of Natural Science have been appointed:—Physics: Mr. S. A. F. White. Chemistry: Mr. V. H. Veley, F.R.S. Physiology: Prof. F. Gotch, F.R.S. Morphology: Mr. G. C. Bourne, Mr. Adam Sedgwick, F.R.S. Botany: Mr. P. Groom, Mr. R. W. Phillips. Geology: Prof. W. J. Sollas, F.R.S., Dr. J. W. Gregory.

There are thirty-eight entries this year in Natural Science; eighteen of these are in physiology, twelve in chemistry, three in animal morphology and physics respectively, and two in geology.

The degree of Honorary M.A. has been conferred upon the Mayor of Oxford, Alderman Buckell, J.P. This is the first time that the University has conferred a degree on the Mayor of the city.

Miss Kingsley gave a public lecture at Manchester College on Friday last, on "The Connection of Fetish with West African Customary Law: a Study in Primitive Religion."

CAMBRIDGE.—The Rev. Prof. Wiltshire has presented to the Woodwardian Museum his valuable geological library, consisting of about 600 volumes and 900 pamphlets.

Prof. Macalister announces a course in Osteology, and Mr. J. E. Marr a course in Practical Geology, in the ensuing Long Vacation.

The Council of the Senate propose the re-establishment of the Professorship of Chinese, held by the late Sir Thomas F. Wade. It is understood that a distinguished Chinese scholar is willing to accept the office without stipend, and to undertake the charge of the magnificent collection of Chinese books given to the University by the late Professor. The collection is said to be unmatched in Europe, and probably in China.

The examination in Agricultural Science for the University's diploma will be held from July 5 to July 12.

The degree of LL.D. is to be conferred on Colonel Maharaj Dhiraj Sir Pratap Singh, K.C.S.I., as representing India, on June 17, when the Colonial Premiers are to receive honorary degrees.

A grant of 300*l.* from the Worts Fund has been made to Dr. A. C. Haddon, towards the expenses of an anthropological expedition to the Torres Straits. It is understood that Dr. Haddon will be accompanied by two or three other Cambridge men skilled in various branches of anthropological research, and by an expert in the Melanesian languages.

A grant of 100*l.* has also been made to Mr. H. H. W. Pearson for botanical research in Ceylon.

Dr. Humphry, Dr. Foxwell, Dr. Sidney Martin, and Dr. Mitchell Bruce have been appointed Examiners in Medicine; Dr. Phillips and Dr. Cullingworth, Examiners in Midwifery; and Mr. Pitts, Mr. Bennett, Mr. Watson-Cheyne, and Mr. Golding-Bird, Examiners in Surgery for the ensuing year.

THE London Technical Education Board has appointed Dr. J. O. W. Barratt to the scholarship in sanitary science. Dr. Barratt will commence his research work under the pathological superintendent at Claybury Asylum during the present summer.

THERE can be no doubt that some of the polytechnic institutions in London are moving towards a higher educational status than they occupied a few years ago. The courses of study are systematised, and they are supervised by teachers who have had laboratory experience; hence they educate the mind as well as train the hand. An announcement that, in the next session (1897-98) Principal Tomlinson, F.R.S., of the South-west London Polytechnic, will establish a class for training in research, affords an instance of the higher tendency of polytechnic instruction. This research training will form part of the curriculum of the second year day electrical engineering students of the institute, but will be open to a limited number of other students provided they can show a fair knowledge of the elementary principles of physics and mathematics. The method of conducting any research will be as follows:—The Principal will first select some subject for investigation suitable for electrical engineering students. He will then fully explain to the class the various reasons which have induced him to make the selection, and will give a brief history of what has been previously done round and about the subject, and full reference thereto. He will also propound a mode or modes of attacking the research, and invite criticisms from the class. When the best mode of attack has been decided on, the class will be expected not only to take part in the experiments, but to help in preparing the required apparatus. Should the results obtained be of sufficient importance, they will be offered in the form of a paper to such societies as the Royal Society, the Physical Society, or the Institution of Electrical Engineers. From time to time during the investigations the Principal will give demonstrations or lectures on those particular branches of magnetism and electricity which bear directly on the investigation, and will illustrate them by the results obtained. The subject selected for the first research is "the effect of repeated heating on the magnetic permeability and electrical conductivity of iron and steel."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"On the Passage of Heat between Metal Surfaces and Liquids in contact with them." By T. E. Stanton, M.Sc. Received April 7.

An experimental investigation was undertaken to determine the rate of transmission of heat from the walls of a heated metal pipe to colder water flowing through it. By means of the apparatus constructed for this purpose the velocity, initial and final temperatures, and pressure of the water, also the surface temperature of the pipe, could be observed; and by varying the initial temperature and velocity of the water, the effect of varying ranges of temperature and velocity of water could be experimentally studied.

The results of the experiments showed that the heat transmitted from any small surface of the pipe

(1) was independent of the pressure of the water;
(2) was proportional to the range of temperature between the surface and the flowing water;
(3) was *approximately* proportional to the velocity of the water;
(4) was proportional to a function of the viscosity of the water; or, putting

H = heat transmitted, S = surface of pipe,
V = velocity of water, T_0 = surface temperature of pipe,
t = temperature of water,

that $$\frac{dH}{dS} = k.(T_0 - t)V^m(1 + aT_0)(1 + \beta t)$$
where $m = \cdot 85$ $a = \cdot 004$ $\beta = \cdot 01$.

It is also shown that these results are in accordance with Prof. Osborne Reynolds' theory of the convection of heat from a hot surface to water flowing over it, this theory being that the motion of heat in the pipe follows the same law as the motion of momentum, as far as convection and conduction are concerned; so that, from Prof. Reynolds' equation for the fall of pressure in a pipe, the value of the slope of temperature may be expressed, the constants in which may be determined by experiment.

In this theoretical expression for the slope of temperature it is seen that the effect of the velocity of the water is very small, which is the most remarkable fact brought out by the experimental research.

"On the Magnetisation Limit of Iron." By Henry Wilde, F.R.S. Received April 3.

In a former paper read before the Society, "On the Influence of Temperature on the Magnetisation of Iron," the author described a new method of determining the magnetisation limit of magnetic substancцs, by which, with a single pole of an electro-magnet, a more exalted degree of magnetisation was indicated, as measured by the force of traction, than had previously been attained (*Roy. Soc. Proc.*, 1891, vol. l.). The magnetisation limit of iron, as deduced from his experiments, was 381 pounds per square inch of section, and it appeared to him at the time that the extreme limit was well within 400 pounds per square inch. The author has recently had occasion to repeat these experiments with other specimens of iron of different lengths, and has increased the magnetisation limit to 422 pounds per square inch, or 29·67 kilos. per square centimetre. He describes an experiment showing that the single-pole method of determining the magnetisation limit of magnetic substances compares favourably with the double-pole method, and that no higher degree of tractive force is to be expected from the latter than has been obtained from the former method.

Linnean Society, May 6.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. Ludwig Radlkofer, of Munich, was elected a Foreign Member.—Prof. Stewart, F.R.S., exhibited and made remarks on some anatomical preparations showing the different modes of attachment of the *Ligamentum nuchæ* in herbivorous and carnivorous mammals, as exemplified in the sheep and dog, and of the *Ligamenta subflava*. The analogous ligaments of birds were dealt with, and special attention was drawn to a preparation of the vertebral column of the python, showing *vertebra-costal fibro-cartilaginous plates* of which he could find no description and which he believed to be peculiar to the Ophidia.—The Secretary read the abstract of a paper by Messrs. W. and G. S. West, on Desmids from Singapore. These had been discovered in a small collection of Algæ forwarded by Mr. H. N. Ridley from Singapore, and, in addition to seven species previously known from Sumatra, contained several which were new, and now described and figured.—Prof. Newton, F.R.S., communicated a paper by Captain F. W. Hutton, Curator of the Canterbury Museum, Christchurch, N.Z., entitled "The Problem of Utility," in which the views of Dr. A. R. Wallace on "The Utility of Specific Characters" (*Journ. Linn. Soc. Zool.*, xxv. pp. 481-496) were criticised, chiefly as tested by the study of the fruit-pigeons (*Ptilopus*).—The Secretary gave an account of a paper by the Rev. R. Bogg Watson, on some new species of Mollusca from the Island of Madeira, prefacing his remarks with a brief *résumé* of the researches previously made in the same direction by Messrs. Lowe, Wollaston, and other conchologists.

Chemical Society, May 20.—Prof. Dewar, President, in the chair.—The following papers were read:—The theory of osmotic pressure and the hypothesis of electrolytic dissociation, by H. Crompton. It is shown that van 't Hoff's view—that the osmotic pressure of a dissolved substance in dilute solution is equal to the pressure which the substance would exercise in the same volume if gaseous—holds when the dissolved substance and the solvent form normal or monomolecular liquids, and may hold when both liquids are associated, but does not hold when one only of the two liquids is associated. When either solvent or dissolved substance is associated, van 't Hoff's formula for the molecular reduction of the freezing point requires modification; on working with the modified formula, it is found that the results obtained accord with the view that electrolytes are monomolecular compounds dissolved in an associated solvent, namely water. The hypothesis of electrolytic dissociation is thus unnecessary for explaining cases of this kind, and is further inconsistent with what is known of the molecular character of liquids. The cube of the association factor of a liquid is approximately proportional to its specific inductive capacity.—Molecular rotations of optically active salts, by H. Crompton. The fact that optically active salts of strong acids have the same equivalent rotations in dilute solution is generally quoted in support of the dissociation hypothesis; the author shows, however, that similar regularities are observed in the case of other salts which are certainly not electrolytically dissociated, so that it would seem that monomolecular salts containing a common optically active radicle have the same equivalent rotation.—Heats of neutralisation of acids and bases in dilute aqueous solution, by H. Crompton. The author explains the constancy

of the heat of neutralisation of an acid by a base with the aid of the views developed in the preceding papers, and thus again shows that the electrolytic dissociation hypothesis is unnecessary. —A comparative crystallographical study of the normal selenates of potassium, rubidium and cæsium, by A. E. Tutton. The author is enabled, from the results of a very complete crystallographic examination of the selenates of potassium, rubidium and cæsium, to extend his previous conclusions deduced from a study of the sulphates and double sulphates of these three alkali metals; he shows that the characters of the crystals of isomorphous series are functions of the atomic weight of the interchangeable elements, belonging to the same family group, which give rise to the series.—The platinum-silver alloys; their solubility in nitric acid, by J. Spiller. The usual statement that, on dissolving platinum-silver alloys in nitric acid, from 5 to 9 per cent. of platinum dissolves with the silver, seems erroneous; the author only succeeded in causing about 1 per cent. of platinum to accompany the silver into solution. —Dalton's law in solutions. The molecular depression of mixtures of non-electrolytes, by M. Wilderman.—The action of bromdiphenylmethane on ethyl sodacetoacetate, by G. G. Henderson and M. A. Parker.

EDINBURGH.

Royal Society, May 17.—Sir Arthur Mitchell, K.C.B., in the chair.—An obituary notice of the late Dr. E. Sang was read by J. Bruce Peebles, Esq., in which he emphasised the desirability of the purchase by Government, or some learned Society, of Dr. Sang's invaluable logarithmic tables.—Dschâbir Ben Hayyán, and the chemical writings ascribed to him. Part ii., by Prof. John Ferguson.—A communication was read by Percy H. Grimshaw, on some type specimens of Lepidoptera and Coleoptera in the Edinburgh Museum of Science and Art. The paper dealt with 52 species of butterflies and 19 of beetles, the type specimens of which had been discovered by the author in a collection purchased by Edinburgh University from M. Dufresne, of Paris, in 1819, and afterwards transferred to the museum. The most important results embodied in the paper are as follows. One of the beetles has been found to be the type of a new genus, the specimen in question being probably unique; it has been found necessary to re-name one species of butterfly and one beetle; errors have been corrected in synonymy, &c., in the case of 19 species; and 8 species hitherto wrongly placed have been referred to their proper genera. The type specimens, together with coloured drawings, by Mr. Grimshaw, of the more important, were exhibited at the meeting. The same author read a short account of a melanic specimen of *Hestina nama*, Doubleday, which had been found in a small collection of butterflies purchased by the museum in 1890. The specimen described is very close, indeed to the aberration named by Oberthür *melanina* ("Études d'Entomologie," xx. 1896, p. 30, tab. 10, No. 177), but differs in several particulars, being generally of a darker tint, the inner series of white markings on the fore wing, and the ferruginous border of the hind wing being absent. The specimen and a coloured drawing of the same were exhibited.

PARIS.

Academy of Sciences, May 31.—M. A. Chatin in the chair.—New studies concerning the history of the lunar surface, by MM. Lœwy and Puiseux.—On the disaggregation of comets. Effect of Jupiter upon short-period comets, by M. O. Callandreau. Regarding a comet as consisting of a swarm of particles of spherical form, the density either being constant or varying only with the distance from the centre of the swarm, an expression is theoretically deduced giving the relations which should exist between the distance from the sun, the velocity, the ratio of the product of the masses of the sun and comet to the attraction constant, and the limiting radius of the orbit of an external particle. Under certain conditions the combined effect upon the disaggregation of the comet of the sun and Jupiter, near aphelion, may exceed that of the sun near perihelion.—Gradual flow of liquids in channels of large section. Fundamental equations, by M. J. Boussinesq.—On the liquefaction of fluorine, by MM. H. Moissan and J. Dewar (see p. 126).—On the function of humic materials in the fertility of soils, by M. Armand Gautier.—Physiological researches on the *sphincter ani* muscle, peculiarity shown by its reflex innervation and contraction, by MM. S. Arloing and Edouard Chantre.—M. Bouquet de la Grye announced to the Academy the loss it had sustained by the death of M. Léopold Manen, Correspondant for the Section of Geography and Navigation.—Report on the precautions necessary in the installation of electric conductors in the neighbourhood of powder magazines. The Committee report that no distinction can be drawn between telephone or telegraph wires and electric light mains. A distance of 10 metres would appear to be sufficient to avoid all risk with underground wires. The same distance is necessary in the case of water and gas pipes, as under certain conditions of leakage from neighbouring conductors they may become dangerous. For overhead lines a much greater distance is advisable, at least 20 metres.—Action of zinc and other metals upon the photographic plate, by M. R. Colson.—On partial differential equations of the second order the two systems of characteristics of which are confused, by M. E. von Weber.—On systems of complex numbers, by M. E. Cartan.—On the convergence of uniform substitutions, by M. E. M. Lémeray.—On the small periodic movements of systems, by M. P. Painlevé.—On the efficiency of gears, by M. L. Lecornu.—On a means of recognising a good cryoscopic method, by M. Ponsot.—On the purification of cerium, by MM. Wyrouboff and A. Verneuil. The oxides arising from the ignition of the oxalates are dissolved in nitric acid, and ammonium nitrate added in certain proportions to the warm solution. The whole of the cerium existing as Ce_3O_4 is precipitated as a basic nitrate which contains neither didymium, lanthanum, nor yttrium earths.—Remarks by M. Moissan on the preceding paper. By fractionally dissolving impure cerium carbide in dilute acids, the solution obtained furnished on simple calcination a perfectly white oxide of cerium. — On the alloys of the silver-copper group, by M. F. Osmond.—The phosphorescence of strontium sulphide, by M. José Rodriguez Mourels.—Contribution to the study of the preparation of ordinary ether, by M. L. Prunier. The presence of sulphur dioxide among the usual products of the crude ether distillate, is accounted for by the formation of ethyl isethionate, $CH_2.OH.CH_2.SO_2.OC_2H_5$, which splits up at 140° into SO_2 and alcohol.—On some combinations of phenylhydrazine with metallic chlorides, by MM. J. Ville and J. Moitessier.—Apparatus for the commercial analysis of gases, by M. Léo Vignon. The apparatus is of the Orsatt type; but calculations are given, taking into account the effects of the dead space, so considerable in this class of instrument.—On the products of decomposition of calcium carbide, and on its employment as a phylloxericide, by M. E. Chuard. After the acetylene has been produced by the action of water, ammonia continues to be slowly given off. By preparing a carbide rich in phosphide, a phosphocarbide is produced possessing exceptionally powerful insecticidal properties.—New order of Insectivora of the middle Miocene at Grive-Saint-Alban (Isère), by M. Claude Gaillard.—A self-recording balance, by M. G. Weiss. Designed more especially for physiological purposes. —Remarks on the preceding paper, by M. Bouchard.—On the umbilical vesicule of the Cheiroptera, by M. Mathias Duval.—Medical statistics of the army of occupation at Cochin China, by M. Bonnafy.—On cases of radiographic erythema of the hands, by MM. Paul Richer and Albert Londe.—On the application of photography to the registration of effluvia given off by living beings in both normal and pathological states, by MM. Luys and David.—On aurora borealis, by M. E. M. Pozzi.—On a general equation of fluids, by M. G. Perry.

NEW SOUTH WALES.

Linnean Society, March 31.—The President, Mr. Henry Deane, in the chair.—The President delivered the annual address. The special subject of the address was an expansion of matters treated of in that of the previous year, namely, a consideration of the relations of the fauna and flora of Australia to those of other parts of the Southern Hemisphere. The affinities of the floras of the Cape of Good Hope and of West Australia; of South-eastern Australia and New Zealand, and of South America; and the discovery of fossil marsupials of an Australoid type in La Plata and Patagonia were passed in review; and the important bearing of evidence of this kind on the question of former possible land-connections between these countries where now deep seas are believed to exist, was discussed. Other cognate subjects touched upon were the moot subject of the permanence of ocean basins and continental areas; the present state of knowledge of the rigidity of the earth; and the causes of extreme changes of climate in past geological ages. The address concluded with some references to the earliest known dicotyledonous plants in

Australia and Europe.—Prof. J. T. Wilson was elected President for the current year.

Monthly Meeting.—Prof. Wilson, President, in the chair.—Descriptions of new Australian Lepidoptera, with notes on synonymy, by Oswald B. Lower. Twenty-six species referable to the sections Bombycina, Geometrina, Noctuina, Pyralidina and Tineina, were described as new.—Studies in Australian entomology, No. 8. Descriptions of two new Tiger-beetles, by T. G. Sloane. A new species of *Megacephala* from West Australia and of *Tetracha* from Barrow Creek, Northern Territory of South Australia, were described.—Notes on Australian fungi, by D. McAlpine. Ten species were added to the cryptogamic flora of New South Wales, of which six were described as new, and four were recorded for the first time, one of them in association with a new host.

DIARY OF SOCIETIES.

THURSDAY, JUNE 10.

MATHEMATICAL SOCIETY, at 8.—Models of the Regular Convex and Star Solids: W. W. Taylor.—The Calculus of Equivalent Statements (Sixth Paper): H. MacColl.—On the Primitive Substitution Groups of Degree Fifteen: Dr. G. A. Miller.—A Generalised Form of the Binomial Theorem: Rev. F. H. Jackson.

FRIDAY, JUNE 11.

ROYAL INSTITUTION, at 9.—Diamonds: W. Crookes, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Theory of the Motion of the Moon; Note on the Mean Motions of the Lunar Perigee and Node: Prof. E. W. Brown.—Elements of Comet Perrine (*f*) 1896 November 2: C. J. Merfield.—Nebula ℍ I. 43 Virginis: Prof. K. D. Naegamvala.—The Shower of Leonids in 1897: W. F. Denning.—Results of Double Star Measures with the 8-inch Equatorial at Windsor, New South Wales, in 1896: John Tebbutt.—*Probable* Papers: Notes on the Reduction of Stellar Photographs: A. A. Rambaut.—Photographic Observation of Comet *b*, 1896: A. A. Rambaut.

PHYSICAL SOCIETY, at 5.—The Effect of Sea-water on Induction Telegraphy: C. S. Whitehead.—A New Definition of Focal Length, and an Instrument for its Determination: Thomas H. Blakesley.—On the Decomposition of Silver Salts under Pressure: Dr. J. E. Myers and Dr. F. Braun.—On a New Way of determining Hysteresis in Straight Strips: Dr. Fleming, F.R.S.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, JUNE 12.

ROYAL BOTANIC SOCIETY, at 4.

LONDON GEOLOGICAL FIELD CLASS.—Excursion—Coulsdon to Merstham. Lower Chalk. Leave Cannon Street, 2.17; arrive Coulsdon, 2.59.

MONDAY, JUNE 14.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Note on a Possible Danger from Fire involved in the Transport of Barium Peroxide in Wooden Barrels: Dr. A. Dupré, F.R.S.—The Valuation of Commercial Nitrate of Soda: Dr. Pauli.—Recent Improvements in Smokeless Compounds and in Processes of Manufacture: Hudson Maxim.—Comparative Experiments on the Estimation of Phosphoric Acid: Alexander Cameron.—The Strength of Commercial Formaldehyde Solutions: W. A. Davis.

TUESDAY, JUNE 15.

ZOOLOGICAL SOCIETY, at 8.30.—On the Mammals obtained by Mr. John Whitehead during his Recent Expedition to the Philippines. With Field-Notes by the Collector: Oldfield Thomas.—On the Presence of Ribs in *Polyodon* (*Spatularia*) *folium*: Prof. T. W. Bridge.—On the Spiders of the Family *Theraphosidæ* (*Mygalidæ*) from the Ethiopian Region, contained in the Collection of the British Museum: R. I. Pocock.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.

WEDNESDAY, JUNE 16.

ROYAL METEOROLOGICAL SOCIETY (Burlington House), at 4.30.—The Non-Instrumental Meteorology of London, 1713–1896: R. C. Mossman.—Hailstorm in the South-West of London, April 27, 1897: Charles Harding.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Palates of Molluscs from a Collection recently presented by Mr. C. Rousselet.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On the Distribution of *Primula elatior*, Jacq.: Miller Christy.—On the Acari collected by Mr. H. Fisher, Naturalist of the Jackson-Harmsworth Polar Expedition, at Cape Flora, Northbrook Island, Franz-Josef Archipelago, in 1896: A. D. Michael.—Further Observations on Stipules: Sir John Lubbock, Bart., F.R.S.—On Minor Tension Lines between Plant Formations: Prof. Conway Macmillan.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Reduction of Perthiocyanic Acid: F. D. Chattaway and H. P. Stevens.—Molecular Refraction of Dissolved Salts and Acids, Part II.: Dr. J. H. Gladstone, F.R.S., and W. Hibbert.—On a Space Formula for Benzene: Prof. J. Norman Collie, F.R.S.—On the Production of some Nitro- and Amido-oxypicolines: Dr. A. Lapworth and Prof. J. Norman Collie, F.R.S.—The so-called Hydrates of Iso-propyl Alcohol; Dr. T. E. Thorpe, F.R.S.—The Carbohydrates of the Cereal Straws: C. F. Cross, E. J. Bevan, and C. Smith.—Further Experiments on the Absorption of Moisture by Deliquescent Substances: H. Wilson Hake.

MINERALOGICAL SOCIETY, at 8.—On Blödite from the Punjáb: F. R. Mallet.—On Monazite and Xenolime in European Rocks: Orville A. Derby.—On the Identity of Sundtite and Webnerite: G. T. Prior and L. J. Spencer.

FRIDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Sub-Oceanic Changes: Prof. John Milne, F.R.S.

SATURDAY, JUNE 19.

GEOLOGISTS' ASSOCIATION—Excursion to Leighton Buzzard. Director: A. C. G. Cameron. Leave Euston, 9.10 a.m.; arrive Leighton, 10.47 a.m.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Naturalist in Australia: W. Saville-Kent (Chapman).—Scientific Romances: C. H. Hinton, second series (Sonnenschein).—Waste and Repair in Modern Life: Dr. Robson Roose (Murray).—W. and A. K. Johnston's Geological Map of the British Isles, revised edition (Johnston).—Mineralogical Geology. A Synopsis for the use of Students, to accompany ditto: A. Johnstone (Johnston).—Smithsonian Institution. Annual Report to July 1895 (Washington).—U.S. Department of Agriculture. Weather Bureau. Report of the Chief of the Weather Bureau, 1895–96 (Washington).

PAMPHLETS.—Adriades: P. Pasinii (Venitüs, Visentini).—The Monetary Situation in 1897: G. M. Boissevain (Macmillan).

SERIALS.—Strand Magazine, June (Newnes).—Middlesex Hospital Journal, No. 3 (London).—Journal of the Anthropological Institute, May (K. Paul).—Catalogus Mammalium, nova editio, Fasc. 2 (Berolini, Friedländer).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1897, No. 4 (Bruxelles).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 41, Part 3 (Manchester).—Observatory, June (Taylor).—Himmel und Erde, May (Berlin, Paetel).—Atlantic Monthly, June (Gay).—Annals of the Astronomical Observatory of Harvard College, Vol. xxviii. Part 1 (Cambridge, Mass., Wilson).—Ditto, Vol. xxxvi. (Waterville, Me.).—Fortnightly Review, June (Chapman).

CONTENTS.

THURSDAY, JUNE 17, 1897.

PROFESSOR KLEIN AND TECHNICAL EDUCATION IN GERMANY.

A MOVEMENT regarding the higher technical education in Germany was started a few years ago by Prof. Klein, in conjunction with some of his colleagues (Nernst and others) at the University of Göttingen, which may become a most important factor in the development of technical education as well as of science. It has, however, from the very outset, met with violent opposition, both in University and in engineering circles.

An account of Prof. Klein's scheme, and of the discussion to which it has given rise, cannot fail to be of interest to all concerned with technical education.

The first publication of Klein's on this subject is contained in the lithographed memoir dated Easter 1895, and which has been published in the *Zeitschrift des Vereins Deutscher Ingenieure*, January 1896. In it is proposed the establishment of a physico-technical institute at the University of Göttingen.

The object of this institute he states to be to give opportunity to persons who already possess a certain amount of scientific or technical education to increase both their knowledge and their power of using it.

It is not intended for the education of large numbers, but rather to help the exceptional few who, in consequence of their talents or other favourable circumstances, can spend more time on their education.

Or, as it stands in the original—

"Das zu gründende Institut soll wissenschaftlich oder technich bereits bis zu einem gewissen Grade vorgebildeten Personen Gelegenheit zu weiterer Vertiefung ihres Wissens und Könnens auf physikalisch-technischem Gebiete liefern. Hierbei wird es sich nie um Massen ausbildung, sondern nur um die Förderung einiger Weniger handeln, denen Talent oder sonstige glüchliche Umstände ein Uebriges auf ihre Ausbildung zu wenden gestatten."

The projected institute should combine all the appliances of modern physics with those technically used, but so that the first are subservient to the latter.

In physics the study of nature is nearly always conducted with experiments carried out in the smallest dimensions, whilst the engineer works towards the mastery over nature on the largest scale. The institute should combine both *micro-* and *macro-physics*.

The following are given as the more important departments of the institute: "Precisions-Mechanik" (measuring instruments); theory of elasticity and strength of material; kinematics, including hydraulics and experimental ballistics; practical thermo-dynamics and practical electricity.

It is added that it will scarcely be possible to establish all these at once.

Lectures of a practical nature are to be added on all the subjects.

The importance of practice in drawing and construction is also dwelt upon. The chief thing, however, will be the work in the laboratory.

It is pointed out that this scheme will enable the engineer to take a University degree by a scientific thesis on some technical subject.

The qualifications of a director and an estimate of the necessary expenditure are next discussed. The latter is put down at about 15,000*l.* as the initial expense, and the annual cost as 750*l.*, exclusive of the director's salary.

Then follows a more minute discussion of the plan and its relation to the Reichsanstalt in Charlottenburg, its connection with the University, the advisability of such an institute from the engineer's point of view, the benefit it will be to the University, and the suitability of Göttingen for such an institute.

The first thing which will strike every one in reading this will be that there is nothing more proposed here than is, or might be, carried out in many of the higher technical schools, and that the whole has been devised at the University somewhat in ignorance of what the technical schools are doing. Nothing, therefore, seems more natural than that from these a unanimous voice against it should have been raised. Klein himself has fully acknowledged this defect in this first statement of his scheme.

To form a true idea both of his high aims and of their importance for technical education, it is necessary to enter into the criticism already mentioned, which the plan has received from engineers and engineering professors, and into a number of further publications by Klein on the subject, mostly addresses read at meetings of engineers and teachers.

A perusal of these papers brings out clearly the following points.

There has grown up in Germany a strong feeling of antagonism between the technical high schools ("Technische Hochschule" is the name now generally given in Germany to the colleges devoted to higher technical education) and the Universities. The new life infused into Germany since its unification, and the great impulse given thereby to German industries, has naturally had its influence on the technical high schools and on technical education in general; but the Universities have remained almost uninfluenced by it. They have remained stationary whilst the others have progressed, and the engineers have more than ever looked with sovereign contempt on these ancient and, to their minds, fossilised seats of learning.

But their progress has been hampered by the unsatisfactory preliminary preparation of the students on entering on their technical studies, and so the whole question of secondary education comes in, just as it does in England. To remedy this, and make the school teaching less classical, and to bring it into closer connection with the requirements of modern life, the technical high schools now claim that the teachers of mathematics and science should be educated by them, and not at the Universities. At the same time, they feel the need of attaching to themselves, or where they exist already to extend, just such laboratories as Klein described, and they maintain that these can only be useful to the development of industry if they are under their direction, and further, that any money given by the Government to the Universities would be taken from *them* and utterly wasted.

There has also been going on a gradual reformation in the programmes recommended to the students, and an endeavour to restrict the purely theoretical parts, and to dwell more on the increase of power in the students to

apply their knowledge instead of increasing the knowledge itself, and altogether to bring the teaching into closer connection with practical needs; to increase the *Können* as opposed to the *Wissen*.

It may be mentioned here that the engineering course in Germany extends over four years, and the students generally enter about the age of eighteen, having, as a rule, spent one year at works beforehand; so that they do not enter practical life till they have, on an average, reached an age of about twenty-three years or more, as one year of military service has to be taken into account. Even then those who want to enter into the service of the State are tied down by the necessity of passing a final examination at about the age of twenty-seven.

It is felt that this age is altogether too high, and to remedy this requires, in the opinion of the technical professors, that the students should be better prepared at school, so that the more elementary part of mathematics and physics can be left out of their course.

The most active of these technical professors is Prof. Riedler, at Charlottenburg, who is well known in this country as a successful practical engineer. His plans for reform have been published in the *Zeitschrift*, 1896, and from recent numbers of the same periodical it becomes apparent that his proposals have in the main been carried out at Charlottenburg. In reading through these, one thing is very striking: a great deal of what he writes on the aims of the highest technical education might have been written by Klein in favour of his plans; in fact, Riedler lays it down as a necessary duty of the technical high schools to care for the highest scientific education of a few engineers.

He says already in 1895 (*Zeitschrift*, August 10, 1895), after discussing the needs of the average students, "Die Hochschule muss jedoch mehr bieten, sie muss einer beschränkten Zahl wissenchaftlich Begabter die höchste Stufe Mathematischer Bildung zu erwerben; aber diese muss eine fruchtbare sein und kann erst dem Fachwissenschaftlichen studium nachfolgen

"Die Universität Leipzig hat angeblich diese höchst zeitgemässe Aufgabe erfasst, sie wäre aber für die Technische Hochschule näher liegend. Wo sollen die Universitäten ins gesamt auch nur eine Lehrkraft hernehmen, die den Ingenieuren das versprochene und Nothwendige bieten könnte?"

Riedler develops his ideas still further in 1896 in several articles (*Zeitschrift*, pp. 301, 337, 374), and also criticises Klein's scheme, of course as a strong opponent.

From these quotations it is clear that he feels the same need for the highest technical education as Klein; but we may well turn his question round and ask where will he find a professor who can teach the *highest* mathematics to technical students, and who is at the same time a practical engineer? Here Klein comes in; his plan will help to educate such men.

Riedler has in these papers a fling at higher mathematics as cultivated at the Universities, where "Abel and Riemann" count much, where one lives in regions in which θ-functions disappear, and in hypo- or meta-geometry, where "dimensions cease and manifoldnesses begin," and where the student learns "gymnastics in four dimensions."

It is easy from a "practical" point of view to make light of many parts of pure mathematics. Even Klein professes that he has often had doubts whether those theories in which the mathematician delights are really worth the trouble of increasing and developing, and in his opinion they would not be if they should never be of use in application to physical and engineering problems.

But, he adds, he has always come away from such contemplations with the conviction that his (and all mathematicians') optimistic views are justified by the belie that they will assist in due time in subjugating nature to science. In fact, the history of science is so full of examples that it is unnecessary to quote any.

If Riedler should succeed in getting the influence of all those speculations banished from the Hochschule, these will soon become as fossilised as the Universities, in his opinion, are at present.

But let us return to Klein's plans. His chief idea, as gathered from the various papers and from his own expressions during his recent visit to England, can be stated briefly enough.

He wants to bring together again theory and practice; he wishes the Universities to take their proper place in modern German life, which differs from that of former days by its enormous energy in industry and commerce. He acknowledges that much has been done outside the Universities, and for purely practical purposes, to develop science; that altogether new methods of investigation have been invented by engineers, and not only in physical investigation but even in mathematics.

He wishes to introduce these at the Universities to enable them to fulfil their duties properly, and he hopes by thus raising these institutions to enable them so to develop science that the results will be practically useful and repay the debt to engineers which science now owes them.

But he also hopes greatly to improve the education of mathematical and science teachers. There can be no doubt that the chief education of these must and will remain in the hands of the Universities—that they cannot be left to the technical schools. It is quite impossible to establish schools exclusively for future engineers, because it is impossible to settle at an early age what career a boy will select, and the majority of schools must be of a general character.

But what is highly desirable is that all teachers, not only the scientific ones, should be better prepared in science, and should gain a higher idea of the value of practical work, and that the old spirit according to which education can only be gained through the old languages, should be broken.

Not only the would-be engineers, but all boys must be made to feel this change, and therefore all teachers must be imbued with modern notions. To have some educated at the University and some at the technical schools would intensify the existing antagonism between science and classics. This ideal education of teachers can only be obtained at the Universities, and here only if these are themselves modernised. Klein's scheme tends to bring this about; it does not exclude the possibility of some teachers of science and mathematics being educated at high schools, nor that many of these should spend a part of their time in studying at a high school; it would be easy to devise a plan by which this could be accomplished.

Klein also hopes to help the engineer directly. The problems taken up by University men are at present without direct connection with practical needs, simply because the latter are unknown at the Universities. Klein wants to make these needs known to the University teachers in order to make it possible to direct their energies in the channels useful to engineers. Again, by having at hand a technical laboratory, and having connected with this all the intellectual resources of the University, it will be possible to bring to bear on technical problems such scientific power as is not likely to be found elsewhere.

To the same end he wishes to make important English scientific papers on technical subjects accessible to German physicists and engineers through translations, and a beginning will be made with Prof. Osborne Reynolds' paper on "Friction of Lubricated Bearings." Dr. Routh's "Rigid Dynamics" will also be translated.

It will be seen from this that Klein's scheme does not affect the ordinary education of engineering students, but that he takes a far higher flight which will not affect the routine at the high schools. Indirectly it cannot fail to raise the whole profession, the whole education of Germany; and if it is carried out in the spirit in which it is conceived, and is ably supported by his colleagues, it will have far-reaching consequences.

That the original memorandum did not reveal the full meaning of Klein's scheme can be explained by supposing that he had himself suffered from the want of direct contact with the engineering profession, and, besides, by his taking it for granted that every one would understand that he was speaking only of the *highest* part of the education of engineers, and that he did not dream of establishing a new engineering school to compete with the old ones.

As soon as he became aware of the opposition raised, he tried by personal intercourse to put himself right, and to destroy the false impression originally created. He went to meetings of the Engineer's Verein at Aachen and Hanover, in 1895, and expounded his plans, with the result of converting many to his views. When he found that the high schools were preparing schemes for laboratories of their own, he at once gave up all idea of asking the Government for money, considering that here the high schools had the first claim, and set about to make private means available in English and American fashion. He succeeded in interesting influential and wealthy manufacturers in his cause, who formed a committee which has promised and guaranteed him a sum sufficient to start one laboratory. For this purpose the thermodynamic laboratory has been selected, and is now in course of erection. As to the choice of a director, he has asked Prof. Linde's advice, who has recommended a pupil of his own; and all will agree that Linde's name is sufficient guarantee that the new director has been educated in a truly practical spirit.

Prof. Klein's plan does not in the least collide with the legitimate aims of the technical high schools; such collision only takes place with regard to the education of teachers, and here the claims of Riedler and others seem to us to be altogether unreasonable.

Klein is altogether the right man to carry out the plan successfully. His singleness of mind is conspicuous to every one who has come, however slightly, in contact with him. As a mathematician he is known and honoured all the world over. He possesses a strong faculty for geometrical conceptions, and likes, with wonderful success, to clothe every mathematical investigation in a geometric garb, or to illustrate it geometrically. His book on the *Ikosaeder* is a brilliant example of this. He, more than any other, has tried to remain in contact with the school teachers of mathematics, and has often put the results of profound mathematical speculations in such a form that they become available for school teaching.

To make the teaching of geometry more real he started, when Professor at the Munich Technical High School, the modelling of surfaces by the students; and the whole large collection of models on sale by Brill in Darmstadt may be said to have grown out of this. For the same reason, he has introduced at the University a course of geometrical drawing. He dwells not less on the necessity of developing facility in performing arithmetical calculations.

All engineering teachers in England will wish that English schoolmasters had been drilled in these two directions.

By descent, and from the environments in which he grew up, he has, from his youth, been familiarised with industry and manufacture.

The traditions of Göttingen, too, are greatly in his favour, and have helped to ripen his plans. Here Gauss worked for years at all possible problems ranging from pure abstract theory of numbers to the invention of an electric telegraph, and of a method of signalling by the sun's rays, now so extensively used in the English army. He enriched science as well as engineering with many important gifts; the theory of least squares, the absolute measure of force, the theory of magnetism, and all his work in connection with Weber.

What Gauss did alone, that Klein wishes to continue in combination with others; he justly observes, also, that a small town is more suited for his experiment than a large town with all its distractions.

We can only wish him success in his bold undertaking, and feel sure that, even if German engineers should carry their antagonism so far as to try to starve his undertaking by preventing young men from making use of the opportunity he offers them, which is most improbable, there will come to him, as heretofore, many eager students from England and America. O. HENRICI.

A WELL-KNOWN TEXT-BOOK OF CHEMISTRY.

A Manual of Chemistry, Theoretical and Practical (based on Watts' edition of Fownes' Manual). By William A. Tilden, D.Sc., F.R.S. Pp. xvi + 599. (London: J. and A. Churchill, 1897.)

THE preface to the original edition of Fownes' *Manual* is dated October 5, 1847. The merits of that book, published about half a century ago, were known to all. But, inasmuch as Prof. Tilden says in his preface to the present work "the last traces of Fownes have disappeared in the process" of re-writing, it is a manual of chemistry by Dr. Tilden, and not Fownes' book, that is to be reviewed here.

The task undertaken by the reviewer is a difficult one. I have tried to discover the principles on which the book is constructed, and to follow the method whereby these principles are applied. I trust, and I expect, that the criticisms I make will not be regarded by the author as the flippancies of an irresponsible reviewer, but that he will believe I am serious and as anxious as he is, up to my lights, to promote the study of chemistry.

What is the subject-matter of chemistry? If I am justified in taking this book as (among other things) Dr. Tilden's answer to that question, then, in my opinion, the answer is wrong.

The opening sentence of the *Introduction* reads well.

"The science of chemistry has for its object the study of the composition of the materials out of which are formed the earth, the sea, the air, and the organised and living beings which inhabit them. Chemistry also seeks to explain the composition of bodies and their properties."

If this is taken with the statement on page 12,

"it is no longer sufficient to determine composition. The aim of the chemist is to ascertain the relation of composition to the physical properties of a body,"

we have a description of the subject-matter of chemistry which seems to me fairly adequate. Would it not have been better to have omitted the word *physical* in the last sentence of the words quoted?

But the book does not fulfil the promise of the *Introduction.* The study of the compositions of bodies; the study of the properties, especially the reactions, of bodies; and the study of the connections between the compositions and the properties of bodies; that, surely, is the business of chemistry. And the one method by which this business can be conducted successfully is the comparative method. If a student is to acquire a genuine knowledge of that branch of natural science called chemistry, it seems to me he must be led constantly to compare and contrast facts in order that he may be prepared to receive, and comprehend, the generalisations of the science. The foundation cannot be laid firmly unless the builder is thinking of the structure he means to raise upon it. To vary the illustration: if the student of chemistry has shot over him loads of sterilised facts he soon is smothered; and if attempts are made to restore him by drawing him out now and then and submitting him to a cold douche of theory, the spark of life that was left in him is likely to be washed away.

After carefully reading much of this book, I am driven to the conclusion that it fails to connect the facts it records with one another, and with the generalisations which rest on the facts, marshal these facts into order, and suggest other facts. Moreover it seems to me that the generalisations of the science are not stated with sufficient fulness, lucidity, and suggestiveness; that the hypotheses of chemistry are not enunciated in such a way as makes it possible for the student to hold them firmly in his mental grasp, and at the same time to be ready to let them go when they have served their purpose of aiding clear thinking; and that the theories of chemical science are not brought into just proportion with the facts and the hypotheses which they ought to bind together and to vitalise.

I admit the enormous difficulty of dealing accurately, lucidly, and suggestively with the vast quantity of facts that has been accumulated by the labours of generations of chemists. I admit the insuperable difficulty of fitting all the many hypotheses of chemistry into their proper places. I do not deny the impossibility of treating the theories of the science, especially in an elementary book, so as to command the assent of so fractious a fraternity as the chemists. Still I think that a serious and painstaking effort should be made by every writer of a manual of chemistry to compare and contrast facts with facts, and to show that the hypotheses and the theories of the science rest on, while they pass beyond, and illuminate, the facts of the science.

It would be manifestly unfair, even in a review to which the writer's name is attached, to find such fault with a book as I have found with Dr. Tilden's *Manual*, without going into some details to justify the fault-finding.

On pp. 16 to 20 a brief account is given of chemical nomenclature and notation. The facts regarding the compositions of compounds which are conveyed by chemical formulæ are expressed in these pages in the language of the theory of atoms. But that theory has not been explained to the student; it has been sketched in the merest outline only. Indeed the theory could not be explained at this early stage of the student's progress. This method seems to me to be entirely wrong; I am certain it cannot conduce to correct thinking.

The *Introduction* is followed by chapters wherein are recounted, and illustrated, the preparations, and some of the properties, of the non-metallic elements and their more important compounds. These chapters also contain lucidly written accounts of those general properties of gases which are of importance to the chemist; of the structure of flame; of some of the phenomena of solution; and of other important matters. Then follow chapters on the laws of combination, the atomic and molecular theory, classification, crystallisation, allotropy and isomerism, heat and chemical affinity, and electrolysis. These are succeeded by accounts of the preparations and properties of the metals and the compounds of the metals.

It is not with the chapters or paragraphs which convey information about the elements and their compounds that I find fault. Much, I think one may say most, of what is contained in these chapters is written clearly and accurately; a selection is made—I think on the whole a good selection—from the enormous number of those facts which are the building stones of the edifice of chemistry. What I complain of is that these building stones are not employed to construct a building; they are arranged in heaps, and each heap is duly labelled;—but, that is all. If chemistry is a collection of bundles of information loosely held together by a few strings of generalisation, then the method of this book is excellent. The separate pieces of information are conveyed in clear and accurate terms. But, in my opinion, the binding strings are very fragile and they do not prevent the contents of the bundles from being scattered.

Many of the chapters which deal with the principles of the science are unsatisfactory. The *laws relating to combining proportions* are enunciated on pp. 236 to 238 These laws are not stated in sharp and decisive terms For instance

"The *law of definite proportions* affirms that when two substances unite together to form a given compound they can unite only in a fixed proportion; . . ."

Why "*two substances*"? What exactly is "*in a fixed proportion*"? Why "they *can* unite"? Would not a student find much difficulty in understanding the conclusion that is drawn from the law of reciprocal proportions? This conclusion is

"For each element, therefore, there is a fixed proportion in which it enters into any state of chemical union."

The laws of chemical combination cannot be understood without the help of examples worked out fully from the basis of analytical and synthetical data. I cannot find in these pages any statement of the nature of the evidence whereon these fundamental laws rest; nor can I discover any suggestion of the vast importance of these generalised statements of facts—the laws of chemical combination—which we have every reason to regard as true natural laws.

On p. 238 sixteen lines are devoted to *the atomic theory of Dalton*. I am certain that no student could obtain, from the author's statement of this theory, a clear mental image of the Daltonian conception of the atom. On this page occurs the statement

"a group of atoms united together chemically is called a molecule."

And on p. 240, after the enunciation of the law of Avogadro, we read

"by a molecule is here understood a small portion of the substance of the gas made up of atoms which do not separate from one another during the movements of the molecule."

This is altogether insufficient. Reference is made, it is true, to "Kinetic Theory, p. 239"; but no clear and sufficiently detailed statement of what is to be understood by the word *molecule* is to be found in the paragraphs devoted to that theory.

As regards the methods employed for determining the relative weights of molecules and the relative weights of atoms, I do not think that a student of fair intelligence and perseverance will be able to realise these methods as definitely as they ought to be realised, even by a very careful consideration of the paragraphs devoted to these subjects on pp. 241 to 251. About 10 pp., 254 to 264, are concerned with the very difficult subject of *valency* or *atomic value* and the application thereof to constitutional formulæ.

". . . an atom of certain elements can replace or be substituted for only one atom of hydrogen, whereas the atoms of other elements can replace 2, 3, 4, &c., atoms of hydrogen."

Then follow reactions meant to illustrate this statement. And then we read

"This difference of combining or saturating power, originally called *atomicity*, now more appropriately called *valency*, is sometimes denoted by placing dashes . . ."

This is, in my opinion, slipshod and hazy writing, and it cannot but induce to slipshod and hazy thinking.

There is an extraordinary statement on pp. 255, 256 about *the law of even numbers*. This "law," we are told, is that

". . . in all such compounds [saturated or normal compounds] the sum of the perissad elements (that is, elements whose atoms are of uneven valency) is always an even number."

Take the case of the gaseous molecule NO. *The sum of the perissad elements*, to use the author's loose phrase, in this compound is not an even number. Perhaps this compound is not a "saturated or normal compound"? Well, define what you mean by "saturated or normal," and then show that *the law of even numbers* is of any value as an aid to accurate research and accurate thinking. The existence of the three gaseous molecules $InCl$, $InCl_2$, $InCl_3$ disposes of the law of even numbers, if the *law* is anything more than a mere playing with numbers.

I have tried to get some clear notions about *heat and chemical affinity* from the pages which deal with that subject; but I have failed. These pages give one a little information about some portions of thermal chemistry; but the subject of chemical affinity is not really touched on at all.

On p. 287 there is a guarded, but still misleading, statement which comes perilously near an enunciation of Berthelot's *law of maximum work*, which "law" is both false in fact and untrue in principle.

To sum up the complaints I make against this book. There is a want of proportion. There is a failure to appreciate the relative importance of the various parts of the science. There is a failure to describe facts of observation as such, and then to show how hypotheses arise and react on these facts, until a general theory is attained, which illuminates the foundations whereon it rests, and suggests the lines on which search must be made for more facts.

I admit the vast difficulty of writing an elementary manual of chemistry. The past is strewn with failures, to which I have myself contributed. I am exceedingly sorry to say that, in my opinion, this book is not a success.

M. M. PATTISON MUIR.

PHILOSOPHY AND PHILOSOPHERS.

History of Philosophy. By Prof. A. Weber. Translated by Dr. F. Thilly. Pp. xi + 630. (London: Longmans and Co., 1896.)

System der Philosophie. Von W. Wundt. Zweite umgearbeitete Auflage. Pp. xviii + 689. (Leipzig: Engelmann, 1897.)

FOR Prof. Weber the chief interest of his subject obviously lies in the post-Kantian schools, and his own solution of the problem of philosophy, as shaped by the influence of the conceptions and methods of the natural sciences on the one hand, and by the exigencies of ideal and optimist ethics on the other, is in the direction of a "concrete spiritualism." The key-word of this he finds in will or force rather than reason, but a *Wille zum Guten* in place of Schopenhauer's will to live. It is in virtue of his firm hold upon modern problems that his review of the way in which they have been historically evolved is so far successful that some, at least, of the dry bones of the History of Philosophy are made to live. Those writers whose antagonism to a dualist metaphysic makes them forerunners of the post-Kantian development—Bruno for example, and

more especially Spinoza and Leibniz—are exceptionally well treated, and of the teachers who drew their inspiration from Kant, Fichte and Herbart, and particularly Schelling and Schopenhauer, are handled sympathetically and with discrimination.

Prof. Weber's book has the defects of its qualities. The amount of space allotted to some of the greater philosophers, such as Plato and Aristotle, is restricted, and they are dealt with rather as exponents of phases in development than as thinkers whose positive solutions of the problem are of enduring interest. Thus the *Phædrus* is summed up as "opposing the selfish rhetoric of the sophists with the true eloquence of the philosopher, whose chief object is the knowledge of the invisible world." There is a technical mistake in saying that Aristotle's "first philosophy" has for its object "the queen of the categories—substance." The biological point of view, which is so pronounced in Aristotle, is not brought out, and, in general, it is Aristotle as he influenced later philosophy that Prof. Weber presents to his reader. In the statement that "the *matter* of Plato, Aristotle, and Plotinus is not the matter of the materialists, but what Schelling and Schopenhauer would call *will* or the will-to-be," the suggestiveness is, in part at least, that of a *suggestio falsi*.

In his treatment of Kant, too, Prof. Weber has the after-development so vividly before him that the exegesis of the first *Critique* is somewhat injuriously affected. "Prior or *à priori* to" is, as Prof. Weber uses it, an incorrect phrase. The distinction between image and schema is lost by loose terminology. And, as is perhaps natural, the Refutation of Idealism is slurred as nonessential. Indeed the issue, as between Kant and Berkeley, is not understood; and it is significant that in the account of the latter the *Siris* is not mentioned. Berkeley, that is to say, is labelled idealist and a precursor of Hume, and his own intellectual development has no account taken of it. Another notable omission in the modern period is in the case of Lotze, who is just named and dismissed.

On the other hand, the scholastic period, which has devoted to it a larger proportion of space than is usual, is covered with some success, Prof. Weber's theological and ethical interests giving life to the inquiry. Anselm is admirably handled.

The translation is from the fifth French edition of the Strassburg Professor's book. The American translator has added in notes and appendix an adequate bibliography, without criticism, and with a not unnatural preference for transatlantic editions and translations.

Many of Prof. Wundt's metaphysical views were familiar to the world even prior to the appearance of his "System" so long ago as in 1889; and to offer an appreciation in detail of a well-known work by so great a teacher would be at once an impertinence and an anachronism. In welcoming, however, the second revised and slightly enlarged edition of the "System," it is perhaps permissible to recall some of its characteristics.

Prof. Wundt's idea of a philosophical system is a connected view of existence which shall satisfy both the demands of the understanding and the needs of feeling. It must be strictly *meta*-physical, after and based upon the experiential sciences. Its method may be described, perhaps, as a criticism of working categories, passing from conceptions of the understanding to the transcendent ideas and finding, as the end of the *Regressus* in each limited field, an inadequate point of view which needs supplementing, until we reach our Ontology. The basis of this is Will. But Prof. Wundt can as little accept what he calls Universal Voluntarism as he can the *intellectus infinitus*. Will, without something to will or without a relation of interaction in which to realise itself, is void, abstract, and not will as we know it. The solution of the problem he finds in a system of relatively independent wills in whose interaction ideas (*Vorstellungen*) arise. The principle of unity lies in the moral ideal of humanity. Collective will is a reality, but not in the sense of the school which derives from Schopenhauer.

Prof. Wundt is more happy, however, in his criticism of particular categories. His treatment of purposiveness in organic evolution is quite masterly, though he attaches somewhat too much importance to what he calls *Heterogonie* of ends. In this edition he refers specially to the controversy between Prof. Weismann and his critics in its most recent form, and declares definitely in favour of use-inheritance, though he draws a distinction between the suddenly acquired qualities of an individual and the gradually acquired characters which have become ingrain by like response to like stimulus repeated from generation to generation. He notes with some candour that it might in theory be maintained that the latter are transmitted because they alone are able to affect the germ-plasm. We do not venture to deal with Prof. Wundt's *Holoplasma* and its relation to the views of Nägeli.

The book stills lacks an index, a deficiency specially annoying since the same and allied subjects are taken up under more than one heading. H. W. B.

THE CORAL REEFS OF SAMOA.

Ueber den Bau der Korallenriffe und die Planktonvertheilung an den Samoanischen Küsten nebst vergleichenden Bemerkungen. By Dr. Augustin Krämer. With an appendix "Ueber den Palolowurm," by Dr. A. Collin. 8vo. Pp. ix + 174. (Kiel and Leipzig: Lipsius and Fischer, 1897.)

DANA'S main contribution to the Darwinian theory of coral reefs was a persuasive argument based on the geographical distribution and varying size of atolls and reef-grounds. Darwin had shown that if his theory were true, its most important corollary was that certain lines across the Pacific Ocean were lines of subsidence, and that others are either rising or stationary. Dana pointed out that as we approach the supposed lines of subsidence the areas of the coral reefs diminish, islands of non-calcareous rocks disappear, and the coral islands all become atolls, which gradually contract in size; after this comes a tract of sea without islands, and of great depth. Then, the axis of subsidence having been passed, small atolls reappear, the reverse series of changes occurs, until we reach an area of broad fringing reefs round some rocky island. Dana's most striking illustration of this method of reef distribution was the archipelago of Samoa, in which he described a gradual

passage from the westernmost, rocky island of Savaii eastward, past reefs of diminishing size, to the last member of the group, the small Rose Atoll. Beyond that island there are some 900 miles of open sea, until the small atolls of the Society Islands begin another series leading up to the great Paumotu Archipelago. Dana explained the distribution of the reefs by assuming that the line between Rose Atoll and the Paumotus had rapidly subsided. This suggestion was in harmony with all the known facts. It has been the argument least shaken during the discussion on Dr. Murray's theory, and has accordingly kept some men firm in the Darwinian faith. Funafuti was originally recommended by the original Coral Island Boring Committee as a suitable site for bore-hole, after it had been tested by this principle in order to minimise the chance of stumbling on an area of rising sea-floor.

Now, however, Dr. Krämer, in a detailed description of the Samoan reefs, shows that the facts are not exactly as stated, and that another explanation is available. Dr. Krämer's book opens with a sketch of the literature on the coral reef controversy, which is neither complete nor altogether accurate; for he numbers Admiral Wharton among the defenders of Darwin's theory, and Prof. Sollas among its opponents. He then gives an account of the topography, meteorology and geology of the Samoan group, after which follows a detailed description of the coral reefs. The next section of the book discusses the conditions which determine the limits of coral-reef formation, and in which the most original remarks are those dealing with the influence of heliotropism. (His observations on heliotropism in corals have, by the by, an important bearing on the question of the validity of coral species founded on the nature of the corallum.) He concludes his contribution to the reef controversy by a chapter entitled "a new view of the origin of atolls." Dr. Krämer points out, during his description of the Samoan reefs, that they are not disposed exactly as they should be to agree with Dana's suggestion, that the eastern end of the archipelago is undergoing rapid subsidence. The reefs are not as regularly arranged as has been thought. Proceeding from west to east, Savaii has no very extensive reefs except on the east coast; Upolu, the next island, has large fringing reefs at the west end, fringing and small barrier reefs in the middle section, and unimportant fringing reefs at the east end; Tutuila has only a fringing reef on the southern shore, and two submarine barrier reefs further out; Manua has no important reefs; finally, the easternmost island of the chain is Rose Atoll. These facts appear conclusive that the Dana argument will not hold for its typical locality.

Krämer then proceeds to discuss the origin of the remarkable shapes of atolls, which Darwin thought it was impossible to explain on the view that atolls formed either on the rims of volcanic craters or on submerged banks. Krämer invokes the aid of great geyser eruptions, in order to widen the bases and alter the forms of submarine volcanoes. He points out that the distribution of volcanic ejectamenta depends not only on its specific gravity, for ocean currents and tides carry the material and pile it up in the dead water to the lee of volcanic islands. He reproduces a chart from Dana, showing how the trend of the coral archipelagoes agrees with that of the ocean currents in their neighbourhood; and he supports this by similar charts of the Paumutu and Marshall Islands. The difficulty of deep lagoons he explains by assuming that atolls with such, originated on crater rims; and he is more inclined to Murray's solution theory than are most writers on coral islands, although he remarks that it does not seem sufficient by itself.

The concluding section of Dr. Krämer's book deals with some biological problems of the Pacific Ocean. A few pages are devoted to the reef fauna, considered in reference to its ethnological relations, and then follows a longer account of the Plankton. The author describes his apparatus and methods at some length. The most interesting result given in this section of the book are his statistics of the comparative poverty of the tropical Plankton compared with that of the temperate zones. In an appendix on the Palolo, a worm largely eaten by the Samoans, Tonguese and Fijians, Dr. Collin re-describes its structure from excellent material collected by Dr. Krämer. He agrees with Quatrefages and Ehlers that it is a member of the genus *Lysidice*, and that Gray's genus, *Palola*, must be given up. J. W. G.

OUR BOOK SHELF.

A Treatise on Practical Plane and Solid Geometry. By T. J. Evans and W. W. F. Pullen. Pp. vi + 400. (London: Chapman and Hall, Ltd., 1897.)

IN these 400 pages the joint authors present the student, particularly the one who wishes to restrict his work to the Science and Art Department syllabus of the honours stage of the annual examination held in geometry, with the solutions of a series of problems arranged in an orderly and progressive manner. The problems are, for the most part, those which have been set at the examinations held during the years 1887 to 1896, and their solutions are accompanied, in many cases, by useful hints. There are also included the theories of isometric projection, shadows, and perspective, and several interesting miscellaneous examples, besides some of the less difficult problems which are of fundamental importance. It is not advisable for a student to limit himself entirely to the reading of such a book as this, but using it in connection with a good text-book its value will be very much enhanced: for this reason, the authors have made ample references to existing standard works. No less important are the excellent and clearly printed figures, to the number of 200, which accompany the text; these should be well studied, and, in most cases, re-drawn by the reader himself. For advanced students and teachers this collection of problems and proofs will, without doubt, prove a most useful help in their work.

Les Transformateurs de tension à courants alternatifs. By F. Loppé. Pp. 206. (Paris: Gauthier-Villars. Masson and Co.)

Électromoteurs et leurs Applications. By G. Dumont. Pp. 183. (Same publishers.)

Électro-métallurgie. By A. Minet. Pp. 195. (Same publishers.)

THESE books are the three latest additions to the well-known series published under the title of the Encyclopédie scientifique des Aide-Mémoire. All the volumes in the series have proved handy and serviceable to students of science and technology.

The first part of M. Loppé's work deals briefly with the theory of the transformer, and ideal conditions of construction; the second part is devoted to the classification of transformers, details of construction, the

description of principal types, and the determination of the dimensions of the various parts of a transformer required to satisfy specified conditions.

M. Dumont begins his volume with a short account of the various means used for the distribution of energy. He then deals successively with different kinds of continuous current and alternate current electromotors, the advantages and disadvantages of the two types, and systems of electrical transmission of power.

M. Minet's volume is one of four which it is proposed to publish on electrolysis and electro-chemistry. One will deal with theories of electrolysis; another with electro-chemistry; electro-metallurgy is the subject of the present volume; and electric furnaces and their applications will be treated in the fourth volume. The general laws of electrolysis are described in the introduction to the volume before us, then methods of working in the wet way, with electrolytes containing dissolved salts, and afterwards processes of electro-metallurgy in the dry way, which includes the electrolysis of substances brought to a fluid state by igneous fusion, and electro-thermic reductions.

Cheese and Cheese-making. By James Long and John Benson. Pp. viii + 150. (London: Chapman and Hall, 1896.)

THOUGH this little volume bears the names of two authors, they can hardly be regarded as collaborateurs. What was the origin of the book does not appear, for there is no preface or introduction. Mr. Long writes five chapters at the beginning and three at the end, whilst the intermediate chapters, four in number, are by Mr. Benson. Each author writes independently of the other, and their respective contributions might equally well have appeared as separate pamphlets. The volume, of course, suffers from this lack of cohesion. Mr. Long's chapters are devoted to the principles of cheese-making, the trade in foreign cheese, soft cheese manufacture, Gorgonzola and the varieties of blue or moulded cheese, other varieties of fancy cheese, the milk industry, the principles of butter-making, and creameries and factories. For a chatty or discursive account of the numerous varieties of foreign cheese it may be safe to consult the volume, but the details of manufacture are hardly given with sufficient precision to possess any value for purposes of instruction. Occasionally, too, Mr. Long is a little uncertain in his choice of words, as when he makes reference to districts "where the most luxurious crops are grown"—he no doubt had luxuriant crops in mind. Mr. Benson deals with the best methods of manufacturing Cheddar, Stilton, Cheshire, and Wensleydale cheeses respectively. More care has been bestowed upon this part of the work, which in the hands of an intelligent person might usefully be employed as a guide to the making of the four varieties of English cheese specified. Connoisseurs will agree with Mr. Benson "that a well-made Stilton stands without rival amongst the better-known varieties of cheeses." One disadvantage of the dual but not joint authorship is that there is considerable repetition. Another is that the volume has no index. So well known a continental cheese as the Gruyère seems to have escaped notice, though the Gervais, Bondon, and Coulommiers receive attention. There are no illustrations.

The Naturalist's Directory. Pp. 102. (London: L. Upcott Gill, 1897.)

IT would be interesting to know what the editor of this book means by a naturalist, for we should then be better able to understand why most people whom we regard as naturalists do not appear in his list. The title-page informs us that the book is intended "for the use of students of natural history, and collectors of zoological, botanical, or geological specimens, giving the names and addresses of British and Foreign naturalists, natural history agents, societies and field clubs, museums, magazines, &c." But we have looked in the list for the names of about twenty well-known naturalists, and have not found one of them included. Perhaps the Directory only contains the names of amateur naturalists, or of naturalists inviting exchanges or correspondence?

In "a list of the principal natural history work published during 1896 in the British Isles," we notice a work on metallurgy, and several on chemistry. If these are branches of natural history, then the editor, to be consistent, should include chemists and metallurgists in the Directory.

Flowering Plants. By Mrs. Arthur Bell (N. D'Anvers). Pp. 204. Illustrated. (London: George Philip and Son.)

THOUGH this book is said to be "complete in itself," it it is not a sufficient guide to the beginner in botany, for the first chapter begins with the supposition that another volume has been read, and the meanings of such terms as "calyx," "corolla," "stamens," "pistil" are regarded as part of the mental stock-in-trade of the reader. The book has been written to introduce the reader in an easy and pleasant way to the common flowering plants; but though we read, on p. 157, "You can easily find either the common or the ivy-leaved Toad-flax for yourselves," we search in vain for any description sufficient to enable a young reader to recognise this plant. Most of the illustrations are reproductions of photographs. A few of them are good, but they are usually quite inadequate to enable the learner to identify specimens of the plants he will meet during his country walks.

Twelve Charts of the Tidal Streams near the Channel Islands and Neighbouring French Coast. By F. Howard Collins. (London: J. D. Potter, 1897.)

THESE charts show by arrows the tidal streams around the Channel Islands and as far as the neighbouring coast of France, when it is high water at St. Peter's Port, Guernsey; one, two, three, four and five hours after high water at that port; and six, five, four, three, two, and one hour before high water there. Hence, knowing the time at which high water occurs at St. Peter's Port on any particular day, the direction of the tidal streams in the neighbourhood covered by the charts at any time before or after high water can be seen. The charts are based upon Admiralty observations, and should be of service to yachtsmen in the Channel.

Guide to the Genera and Classification of the North American Orthoptera found North of Mexico. By Samuel Hubbard Scudder. Pp. 87. (Cambridge, Mass.: Edward W. Wheeler, 1897.)

THE tables and bibliographies contained in this book will prove very serviceable to students of Orthoptera in America. All the seven families of Orthoptera are found in the United States, but a large amount of work remains to be done upon them, and this volume will assist in the collection and study of material required for advancement. The author states that he "contemplates a general work on the classification of our Orthoptera, of which this is merely a Prodromus, and which may serve its purpose until the material at hand has been more thoroughly studied."

Aids to the Study of Bacteriology. By T. H. Pearmain and C. G. Moor, M.A. Pp. 159. (London: Baillière, Tindall, and Cox.)

A GOOD general idea of the science of bacteriology, especially in its pathogenic aspects, can be derived from this little book. As an introduction to the "Applied Bacteriology" of the same authors, the book should be welcomed by medical students and by all practitioners who wish to know something of the methods of bacteriological research, and to understand the significance of the results obtained.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On a Method of reproducing Astronomical Photographs.

PROF. MAX WÖLF, in his excellent article on the "Reflector and Portrait Lens in Celestial Photography," published in your issue of April 22 last, mentions a method of "reproducing nebulous masses" from original negatives, and refers to my reproduction of a photograph of the nebula M.8, done in collaboration with Mr. Lunt.

I have since tried the method on a number of other clusters and nebulæ with uniform success.

My practice now is to use a very slow plate capable of giving good contrast, and to give it the least possible exposure during contact-printing from the original negative. I use the ordinary Pyro-ammonia developer with half of the normal quantity of ammonia indicated, and with an excess of bromide. If there is the slightest indication of an image within five minutes, the plate is rejected as too much exposed. The development is continued for about forty-five minutes, with an occasional addition of a little more ammonia; the plate is, of course, kept rocking all the time in the dark. From the positive thus obtained a second negative is secured, and from it a second positive, and from the last a third negative, which is used for final printing on paper. The method of development is throughout the same as mentioned above.

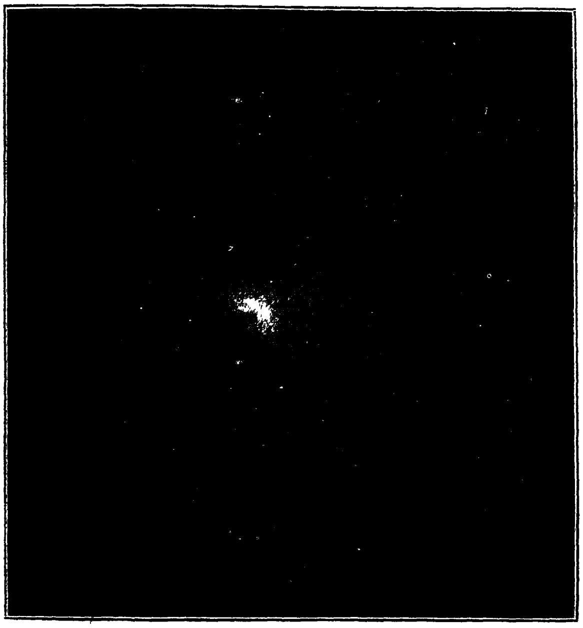
Faint details in outlying portions, for instance, in the photographs of the corona can be very easily brought out in this manner.

No intensification by mercury or otherwise is employed by me, and I consider it absolutely inadmissible, as it is liable to affect the grains in the neighbourhood of the image, and thus to give a false extension of nebulous matter. The pure process of successive copying and bringing out contrast is perfectly legitimate; Scheiner and others having shown that the image does not spread thereby.

I beg to forward for your inspection the original negatives and reproduced copies of M.8 and the Orion nebula, and shall be glad if you can make use of them. K. D. NAEGAMVALA.

June 8.

THE GREAT NEBULA IN ORION.



Original negative.

Negative twice re-copied.

On Mimicry.

DURING the discussion on Mimicry at the last meeting of the Entomological Society, the fact that so many mimetic species are scarce, in comparison with the non-mimetic allies and the models, was brought forward as an argument against the efficiency of mimetic resemblance. Amongst the Indo-Australian Papilios this phenomenon is strikingly illustrated by *Papilio alcidinus* and *caunus*, which resemble their models to a surprising degree. As both these rare species deviate widely from their nearest relatives, it occurs to me that the theory of Mimicry, which says that Homœochromatism and Homœomorphism between imitating and imitated species are the outcome of *selection*, can give a satisfactory explanation of the scarcity of individuals of mimetic forms. If we concede for the sake of argument that, for instance, *Papilio alcidinus* has acquired that wonderful similarity in colour and form to its model, an Uraniid moth, in consequence of a continued selection in the one direction, it is obvious that the result of such a one-sided selection will not only be similarity to the immune model, but also physiological one-sidedness. The more rigorous the selection is, the better will the mimetic species become adapted to its model, and the more will it lose its adaptability to new biological factors. Therefore, when changes in the biological conditions of the area inhabited by the mimetic form take place, such ever-occurring changes as have been described by Wallace in "Natural Selection," the mimetic species, best adapted in one direction, will be at a disadvantage to its relatives which have not been subjected to rigorous, one-sided selection. Consequently, the most striking "mimics," in spite of, or rather in consequence of, the resemblance to immune species, are, in the long run, the less favoured in the struggle for existence, which means that they will become relatively scarce. From this consideration it is apparent to me that the selection of those specimens which are the very fittest in any *special* direction is in itself a danger to the species, and can lead to destruction. The peculiar bearing which this suggestion has on the theory of Natural Selection, especially on the principle of utility, is evident.

Zoological Museum, Tring, June 7. KARL JORDAN.

Immunity from Mosquito Bites.

THE note of your correspondent (NATURE, No. 1438), relative to the above subject, leads me to point out that my own experience is the counterpart of that there presented. More than twenty years ago, as a young man, I camped during the months of May and June in the forest which bordered the south shore of Lake Superior, a region teeming with varied forms of insect-life, among which the mosquito held a conspicuous although not the most obnoxious place. I had previously been very sensitive to mosquito stings, and suffered acutely from them during the entire period spent in camp, my hands and face being so closely covered with the peculiar hard lumps resulting from the sting, that they presented in place of soft flesh only a series of contiguous swellings.

The temporary discomfort thus occasioned has since been abundantly recompensed. For many years afterwards mosquitos displayed a marked antipathy towards my blood, rarely stinging me if any other person were available as a subject for their attacks. This kind of immunity I have now partially lost, but even to the present time a mosquito sting occasions me very little annoyance. It is followed by no swelling, and the pain ceases within a few moments after the proboscis is withdrawn. GEO. C. COMSTOCK.

Washburn Observatory, Madison, Wis., U.S.A.

Sound Signals in Fog.

REFERRING to one of your Notes on page 130, I will take the opportunity of repeating a suggestion which I have several times made privately, viz. to have on board ship not a double emitter but a double receiver of sound:—a pair of trumpet-mouths or collectors or ears, one at each side of the ship, with the bulk of the ship as a shadow-throwing object between (like the head), and with tubes leading from them into the the captain's or other quiet cabin. The listen-out-man, having these tubes in his ears, would be able to hear distant sounds and estimate their direction with greater precision than if he trusted to his own small collecting organs, but I apprehend in just the same sort of way, and almost without training.

June 12. OLIVER J. LODGE.

Fire-fly Light.

IN answer to Prof. Silvanus Thompson's inquiry in NATURE of June 10, it may be stated that the "Johanniskäfer," or "Johanniswürmchen," is the common glow-worm, *Lampyris noctiluca*, L., or *Lampyris splendidula*, L. E. OVERTON.

Zürich, June 12.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.

I.

THE failure of so many of the eclipse parties last year to secure observations, makes it a matter of congratulation that the weather prospects of the eclipse to be observed in India on January 22 next year seem to be as favourable as they possibly can be. I propose in the present article to refer generally to the objects to be attained, and to give an account of the proposed arrangements so far as I know them; and to show how fair the prospect of success this time is, I will begin by referring to a note drawn up by Mr. Eliot, F.R.S. Meteorological Reporter to the Government of India, in order to give the chief meteorological features of the tract of country in India through which the line of totality will pass.

The note begins by giving a general idea of the Indian climate.

"It may be premised that the year in India may be divided into two seasons or periods—the north-east or dry monsoon (or season), and the south-west or wet monsoon. During the south-west monsoon winds of oceanic origin prevail, and the whole of the period is one of frequent rain over the greater part of India. The chief features of this period, lasting from June to December, are moderately high temperature, moderate diurnal range of temperature, high humidity, much cloud, and more or less frequent rain. The amount of cloud and rain differ very considerably in different parts of the country, depending upon their position with respect to the neighbouring seas and the mountain ranges in India, and other conditions. The south-west monsoon winds usually withdraw from Northern India in September or October, and from the Bay of Bengal and Southern India in December. Hence the months of November and December form a transition period from the conditions of the wet to the dry monsoon, the change commencing in Upper India, and extending slowly eastwards and southwards.

"During the dry or north-east monsoon (extending from January to May), winds of land origin prevail in the interior of India. In Northern India these land winds blow down the larger river valleys, and are hence westerly over the Gangetic plain, the largest river plain in India.

"The first two months, January and February, form the cool weather of Northern and Central India and the Deccan. The mean temperature of the day ranges between an average of 71° in the Deccan (Berar, the Central Provinces, and Hyderabad), and 54° in the Punjab. The diurnal range of temperature is large in amount, varying between 25° to 35° or 40° in the interior. The air is usually very dry, skies free from cloud, and winds light, more especially in the Punjab and more remote districts of the interior. The disturbances of this period are feeble cyclonic storms of large extent, which cross Northern India from west to east, and give much cloud and light, to moderate rain in the plains and hills of Northern India. Temperature increases rapidly in March, and that month and the two following months of April and May form the hot weather season. The intensity of the hot weather conditions increases from March to May. The chief features of the weather of this period in the interior of India are high day temperature, large diurnal range of temperature, great dryness of the air, and strong day winds which raise clouds of dust, and more or less obscure the sky and sun. Cyclonic storms of large extent are of comparatively rare occurrence in this period. On the other hand, small local hot weather storms—including hailstorms, thunderstorms, and duststorms—are of frequent occurrence, and tornadoes are of occasional occurrence, in Bengal chiefly."

It follows from this sketch that the eclipse will occur in the middle of the cold weather and at the most favourable time of the year for travelling in India. Light north-east winds, fine weather, and smooth sea are to be expected. Cyclonic storms are of exceedingly rare occurrence in either sea during the month, and the chance of a gale or of stormy weather in the month off the coast of the Konkan (from Bombay to Karwar) is, according to Mr. Eliot, less than 1/50. He states:—

"The weather is throughout the month of January almost uniformly fine, with clear or lightly-clouded skies over the whole of the Peninsula. Light north-easterly to easterly winds obtain in the Deccan, or interior of the Peninsula. The west coast districts are protected by the West Ghats from these winds, and light land and sea breezes prevail. The most remarkable feature of the meteorology of the coast area from Bombay south to Karwar in January is the freedom of the skies from cloud. Disturbances are of very rare occcurence, and fine weather is hence almost a certainty during the whole of the month. There is, however, usually much dust in the air, raised by the dry winds in the Deccan."

Among other most important matter in Mr. Eliot's note is a table showing average temperature, humidity, cloud and rainfall data in January at certain stations in India near the line of totality. We gather that the mean temperature of the month of January in the Konkan coast districts is 76°, with a diurnal range of 20°. In the Deccan (*i.e.* at Sholapur, &c.) and the Central Provinces the mean temperature of the day in January is approximately 70°, and the diurnal range nearly 30°. In Bihar the mean daily temperature of the month is 62°, and the diurnal range 23°.

Mr. Eliot points out that since the air is very dry over the interior, and the mean daily humidity percentages at stations in the Deccan, Central Provinces, and Berar averages about 40°, any instruments brought out from Europe, such as photographic cameras, &c., should be constructed to withstand the action of this great dryness

of the air. With regard to cloud, the data show that the coast districts between Karwar and Ratnagiri (which includes the line of totality) is on the mean of the month more free from cloud than any other part of the line of totality.

"The amount of cloud is practically uniform in amount over the Deccan and Central Provinces, and is slightly greater in Bihar than in the Deccan or Central Provinces. The amount of cloud is very large at Darjeeling in January, and mist or fog almost invariably forms after clear nights in the morning (about 9 or 10 a.m.), and prevails more or less steadily until late in the afternoon, when it gradually disappears."

Rain is of rare occurrence during the month of January in the Konkan and Deccan. Its probability increases in proceeding from west to east. In the Konkan the average number of rainy days in the month is only 0·2, and in the eastern districts of the North-western Provinces the average number is 2, and in Bihar 1·2.

"The probability of a rainy day in January is hence about six times as great in Bihar as in the Konkan in January. The probability of any given day in January being rainy in the Konkan is less than 1/150, and in Bihar 1/25."

Mr. Eliot remarks, in connection with this, that skies are usually remarkably clear after rain in the Gangetic plain, and the atmospheric conditions for astronomical observations are at such times much finer than are ever obtainable in the Konkan or Deccan.

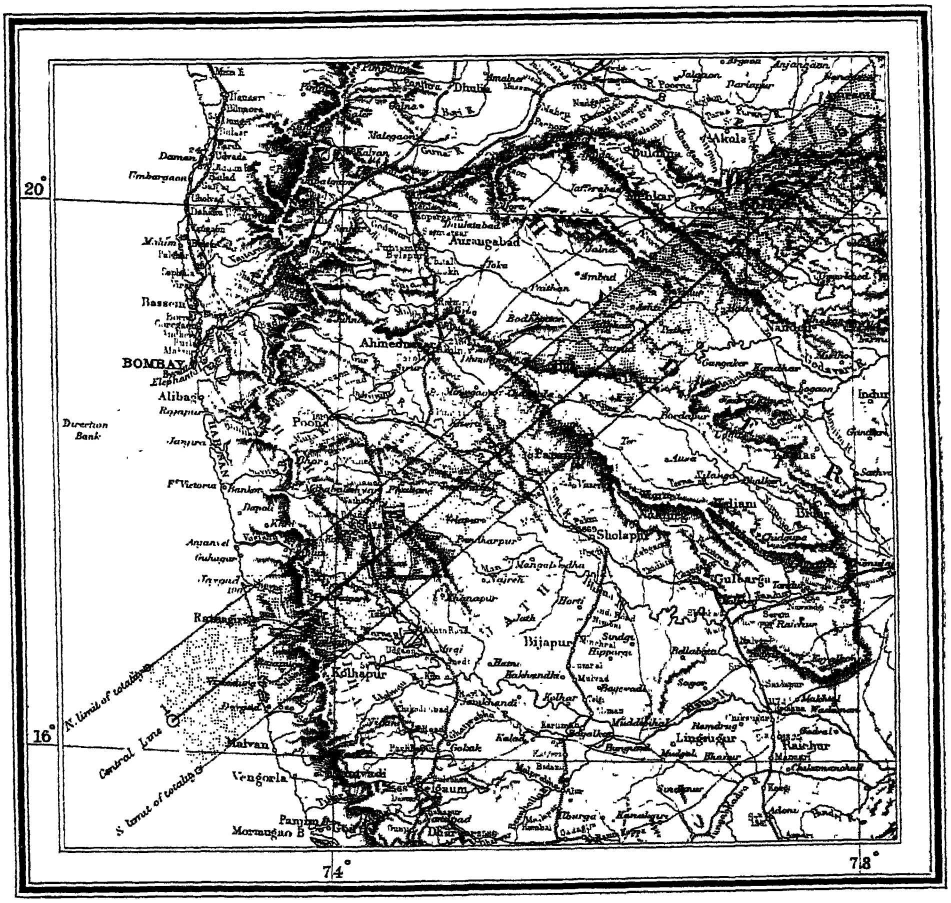
The local astronomical conditions at three points along the line of totality are thus stated in the "local particulars" issued from the Nautical Almanac Office. Local mean times and the points of contact for direct image are given.

Rajapur ... Long. 73° 35′ E., Lat. 16° 40′ N.

	d.	h.	m.	s.	Contact from N. Point.	Contact from Vertex.	Sun's altitude.
Eclipse begins January	21	23	13	58	121° W.	100° W.	52°
Totality begins ,,	22	0	47	42	Duration 2m. 1s·9		53°
Totality ends ,,	22	0	49	44			
Eclipse ends ,,	22	2	15	51	55° E.	13° E.	44°

Nagpur ... Long. 79° 8′ E., Lat. 21° 9′ N.

	d.	h.	m.	s.	Contact from N. Point.	Contact from Vertex.	Sun's altitude.
Eclipse begins January	21	23	56	20	123° W.	118° W.	50°
Totality begins ,,	22	1	26	33	Duration 1m. 17s·7		46°
Totality ends ,,	22	1	27	51			
Eclipse ends ,,	22	2	49	15	55° E.	10° E.	35°



Reg. No. 233 R.. Asiatic Society.—July 26.—40.

FIG. 1.—The central line of Eclipse in Western India.

Position south of Benares ... Long. 83° 0′ E., Lat. 24° 40′ N.

	d.	h.	m.	s.	Contact from N. Point.	Contact from Vertex.	Sun's altitude.
Eclipse begins January	22	0	24	56	123° W.	128° W.	46
Totality begins ,,	22	1	51	28	Duration 1m. 43s·6		40°
Totality ends ,,	22	1	53	12			
Eclipse ends ,,	22	3	10	48	56° E.	10° E.	29°

The Joint Committee of the Royal and Royal Astronomical Societies have determined to send out three parties to observe, one on the coast and two inland, at stations to be subsequently decided upon. It has been arranged that the party from the Solar Physics Observatory will occupy the coast station if the Admiralty can

grant the use of a man-of-war to allow an attempt to be made to repeat the *Volage* programme of 1896.

In this case the station will possibly be the old fort at Viziadurg, for which point the following astronomical conditions hold, according to the Superintendent of the Nautical Almanac (Fig. 2).

Assuming the position of Viziadurg to be 16° 32′ N., and 73° 22′ E., the times of contact are (local mean time) :—

	d.	h.	m.	s.	
1898.—January	21	23	12	20	
,,	22	0	46	9	$P_2 = 241°$
,,	22	0	48	14	$P_3 = 51°$
,,	22	2	14	33	

These times are 4h. 53m. 28s. in advance of Greenwich.

The land parties—which will include the Astronomer Royal, Prof. Turner and Mr. Newall, representing the Observatories of Greenwich, Oxford and Cambridge, together with Dr. Common and Captain Hills—will occupy stations near the central line on the railways shown on the map (Fig. 1).

With regard to the work to be attempted by the coast party, to which I propose to confine myself in what follows, I may state, in the first place, that I am one of

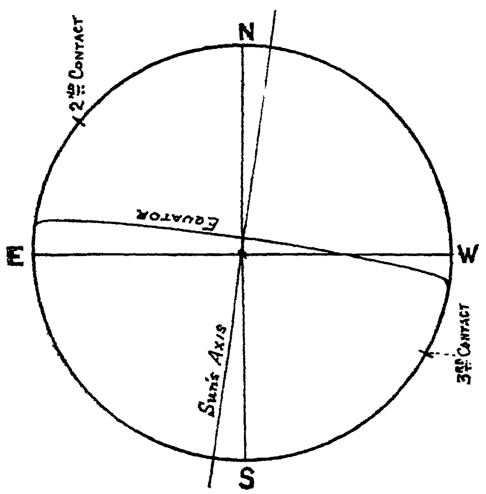


FIG. 2.—The conditions of observation at Viziadurg.

those who believe that spectroscopic observations during eclipses must take precedence of all others in the minds of students of solar physics; but when I say this, it must not be forgotten that other inquiries remain which are much more simply carried out, and are within the competence of those unacquainted with the details of the subject; one of the fortunate things about eclipses is that photographers and amateurs can do good work as well as those more fully equipped.

But to return to the spectroscope—What form of spectroscope are we to employ?

The Prismatic Camera.

Fraunhofer, at the beginning of the century, found that in order to observe the spectra of stars the best thing to do was to put a prism outside a telescope, and to let the light enter the telescope and be brought to a focus after it had passed through the prism; and it is a most unfortunate thing, that the neglect of the application of this principle has landed us probably in a delay of fifteen or twenty years in gathering knowledge on this subject. Now the spectroscopes with which most are familiar are armed with a slit through which the light to be examined is made to enter, and the rays are next rendered parallel before they enter the prism in a part of the instrument called the collimator. After passing the prism they are again collected to a focus by means of a telescope.

But a spectroscope need not be so complicated as this, for after all the object of the instrument is to disperse white light as we see it dispersed in a rainbow, and what nature accomplishes by a rain-drop we can do by a prism; hence, if we simply pass a ray of white light through a prism, we find that after it has so passed through, it is changed into a beautiful band, showing all the colours of the rainbow. This prism then is the fundamental part of the instrument, and the most complicated spectroscope which we can imagine simply utilises the part which the prism plays in breaking up a beam of white light into its constituent parts from the red to the violet. Between these colours we get that string of orange yellow, green, and blue, which we are familiar with in the rainbow. For sixpence any of us may make for ourselves an instrument which will serve the purpose of demonstrating many important spectroscopic results. From an optician we can get a small glass prism for sixpence; glue it at one end of a piece of wood about $12 \times 1 \times \frac{1}{2}$ inch, so that we can see through it a coloured image of a needle stuck in at the other end of the piece

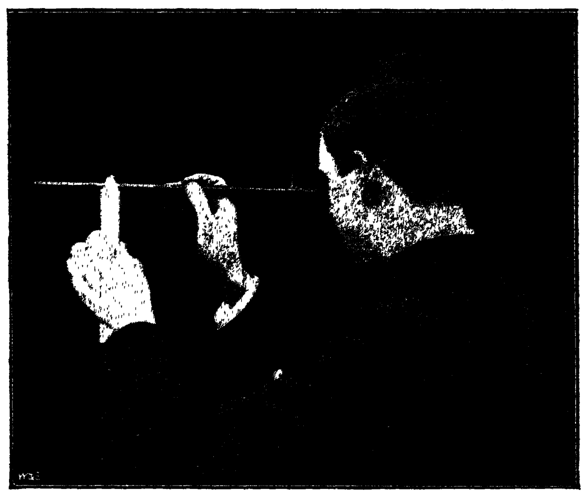


FIG. 3.—A simple form of spectroscope.

of wood (Fig. 3). This we must do by looking sideways through it.

Allow the needle to be illuminated by the flame of a spirit lamp into which salt is gradually allowed to fall. We see an image of the needle coloured in orange. If we next illuminate the needle by a candle or gas flame, taking care that the direct light from the candle does not fall upon the face of the prism, we then get no longer a single image of the needle, but a complete band of colour from red to blue. We have, in fact, an innumerable multitude of images of the needle close together.

It will be clear from these experiments that in our *impromptu* spectroscope we see simply images of the needle, few or many, according as the kind of light we are studying contains few or many differently coloured rays.

In the more complicated instrument we pass from an illuminated needle to a fine straight slit through which light is allowed to enter. We generally talk of "line" spectra for the reason that a narrow slit is employed, the image of which is a line. In the "lines" seen in the spectra of the heavenly bodies we have so many celestial hieroglyphics which we have to translate into chemical

language by comparing their positions with those we observe in the spectra of terrestrial light sources.

But a straight slit is not the only kind of aperture we can employ; we may replace it by a ring, for instance.

What we shall see in passing from the spectrum of a candle to the spectrum of a spirit-lamp flame with salt in it, using first a straight and then a circular slit, is shown in the accompanying woodcut (Fig. 4).

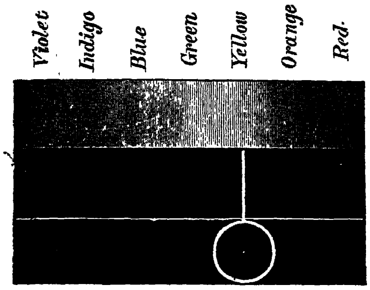


FIG. 4.—The spectra of continuous and discontinuous light sources, the latter seen with a line and circular slit.

If we examine a very complicated light source we shall arrive at the same result, a spectrum characterised by a large number of bright circles or lines (Fig. 5).

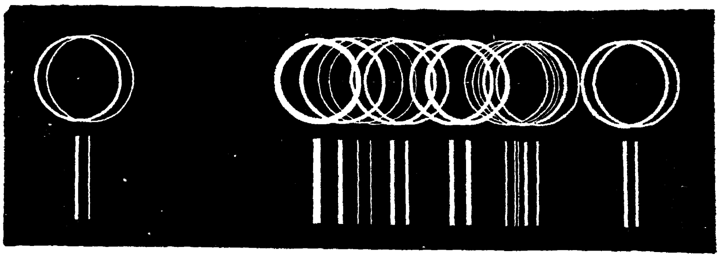


FIG. 5.—The spectrum of a complicated light-source as seen with a circular and a line slit.

FIG. 6.—Details of objective prism.

We have seen that in an ordinary spectroscope, when we are studying light sources close to us, the rays have to be made parallel before they pass through the prism. But the heavenly bodies are at such a distance from us that their light reaches us in a parallel beam, so that one part of the spectroscope, the collimator, may be dispensed with. A star as a point is part of a line slit; hence the success of Fraunhofer's arrangement for observing stellar spectra, to which I have referred. In an eclipse we get a bright narrow ring round the dark moon. There is our ring slit. Hence the so-called "slitless spectroscope," or "prismatic camera," as it is called when photography is employed, used to study the spectra of stars and the sun's chromosphere during eclipses.

The way in which, in the prismatic camera, the prism is fixed outside the object-glass, is shown in the accompanying figure (Fig. 6).

We are now in a position to inquire how this arrangement has been used during eclipses since 1871. J. NORMAN LOCKYER.

(*To be continued.*)

THE OLD RED SANDSTONE OF LORNE.

THE terraced hills of Lorne, though a familiar feature in the scenery of western Argyllshire, have not yet had their geology properly worked out. Their peculiar topography, however, has long been known to arise from the outcrops of successive sheets of lava, lying upon and intercalated with strata of purple shale and conglomerate. The age of these strata has never been satisfactorily settled. For many years past I have regarded them as probably belonging to the Lower Old Red Sandstone, for their lithological characters present a close resemblance to those of the great basin of that age in central Scotland, which I have distinguished by the name of "Lake Caledonia." While recently mapping in the district, Mr. R. G. Symes, of the Geological Survey, came upon an exposure of the sedimentary rocks, which seemed to him so promising a locality for fossils that he requested the assistance of one of the fossil-collectors of the staff with a view to more minute examination. Accordingly, Mr. A. Macconochie was detailed for the purpose, and was soon rewarded by the discovery of undoubted remains of plants and fishes. The specimens were first sent to the Office of the Survey in Edinburgh, where the plants were recognised by Mr. B. N. Peach as portions of *Psilophyton*, and the fish-remains as parts of *Cephalaspis*. His identification of the ichthyolites was immediately confirmed by Dr. R. H. Traquair. The specimens were then forwarded to the Jermyn Street Museum, where they have been again examined by Mr. E. T. Newton, who entirely agrees with the opinion already pronounced regarding them.

The occurrence of a genus of plants and another of fishes so characteristic of the Lower Old Red Sandstone

of central Scotland is of singular interest and importance, for it definitely fixes the geological age of the volcanic series of western Argyllshire and its accompanying sedimentary deposits. ARCH. GEIKIE.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

THE International Congress on Technical Education, referred to in last week's NATURE, was opened on Tuesday, at the rooms of the Society of Arts, under the presidency of the Duke of Devonshire. The meeting of the Congress in London is due to this Society, and to the City Companies, which guaranteed the necessary expenditure.

The subject of higher technical education claims the attention of all who are concerned with the progress of science and the development of arts and industries. The pressing importance of the question is indicated by the article which appears in another part of this number. We take it that the scheme of Prof. Klein, to establish an educational system which will bring theory and practice more closely together, is the ideal organisation. The man of science and the engineer should be one; for both need to understand the practical aspects of nature, and both are constantly inventing methods of investigation. Prof. Klein wishes to give life to fossilised Universities, and lead them "so to develop science that the results will be practically useful, and repay the debt to engineers which science now owes them." This aim, coming from one who has enriched mathematics with so many remarkable contributions, should do much to break down the supposed barrier between the investigator working in his laboratory and the engineer working towards the mastery of nature on a larger scale. For the details of the scheme, we refer our readers to the article in another place. To our mind, the plan proposed will do much to advance higher technical education; and it will perhaps lead to the development of teachers who are good mathematicians as well as practical men. In all countries there are signs of increasing interest in methods of education, so that Prof. Klein's views will doubtless receive consideration outside Germany.

In opening the International Congress, the Duke of Devonshire pointed out that each country could learn much from the experience and organisation of others. It is for this reason that such Congresses have a beneficial effect. In the course of his address, the Duke of Devonshire is also reported by the *Times* to have made the following remarks :—

It is in a double capacity that I have the honour of offering a welcome to the International Congress on Technical Education. We have in this country a Department of Education, but its functions are almost entirely limited to elementary education, and we have not in our Administration any Minister who properly corresponds to the Minister of Education of other Governments. Nevertheless, the President of the Council is the Minister on whom the nearest approach to responsibility for education rests, and the Vice-President, Sir John Gorst—who, I trust, will take part in the future proceedings of the congress —is the Minister who, representing the Government on educational matters in the House of Commons, shares with the President a large part of his responsibility. It is, therefore, partly in our official capacity that Sir John Gorst and I take part in these proceedings. The comparatively unorganised condition of education as a whole has led to the formation of unofficial and irresponsible associations to promote and help to organise special branches of education to meet the growing needs of the country. Turning to the business of the congress, its previous assemblies have done much to increase public interest in the very important question of technical instruction; and the well-arranged and representative programme of the present assembly justifies the hope that its deliberations on the present occasion will be no less fruitful than in the past. The present time is well chosen for an international congress on technical instruction. In all countries there are signs of increasing interest in foreign methods of education. Systems of education, indeed, cannot be transferred ready-made from one country to another. Education is a thing too closely interwoven with national life and habits to permit any such easy transference. But when every allowance has been made for this it remains true that each country can learn very much from the experience and the educational organisation of other countries. Educational ideas and ideals may be communicated, although systems of administration cannot be transferred without great modification and adjustment to special circumstances; we find therefore that in point of fact English education has been materially affected during the last sixty years by waves of foreign influence coming in succession from France, Holland, Germany, Switzerland, America, and Scandinavia. And in some respects there is no department of education in which methods of teaching and plans of organisation can be more readily transferred from one country to another than is the case in technical instruction, which is the subject of the present congress. In many respects this country has been the debtor in this long process of foreign educational exchange. But there is one point at least in which continental critics are now paying Great Britain the compliment of careful study and even of admiration. The need for individual initiative and for freedom of local experiment has always been fully recognised in English education, and in no grade of it has this been more the case than in technical instruction. While the central Government, through its administrative departments, has not failed to give a certain measure of guidance to the new movement, it has thrown the greater part of the responsibility on the local authorities, believing that (in technical education especially) there must be great elasticity in administration and incessant adaptation of the means and form of instruction to meet the great variety of the industrial and commercial needs which exist in the different localities, but can only be ascertained and fully tested by local experiment. The local authorities have, with few exceptions, risen to their new responsibilities with an alacrity and enterprise which deserve high commendation. All of those who are labouring for the extension and improvement of technical instruction in Great Britain, as well as in Ireland, where a remarkable movement is now in progress for the furtherance of technical education, will learn much from the reports brought by the foreign delegates. They will also take special interest in the accounts to be given by distinguished visitors of technical education in Canada, in India, and in Australia. To British hearers probably no part of the discussions will be more instructive than that which is to be devoted to the subject of commercial education. In the field of higher commercial education, Great Britain is believed by many competent observers to be seriously behind several of the continental nations. Attention would also be usefully directed to the influence of Germany, and especially the Realschulen of Berlin, in producing, by means of a carefully planned modern secondary education, given by trained teachers of the highest attainments, an increasing number of youths eminently fitted to profit by the highest kinds of technical education, and to promote the commercial interests of their country.

Papers chiefly relating to different aspects of the teaching of chemistry were then read and discussed.

ALVAN G. CLARK.

A NOTE of extreme sadness is mingled with the congratulations that have followed the completion of the Yerkes telescope. Hardly is the object-glass in its cell, and before the final adjustments can possibly be complete, the intelligence comes that the artist, who has laboured so earnestly and so successfully in the work of figuring object-glasses of the largest size, is struck down suddenly by apoplexy. Ten years ago, Alvan Clark, the founder of the firm, died, after completing the lens of the Lick telescope, but before he could witness its complete installation and be assured of its final success. The son, Alvan G. Clark, was probably aware of the excellence of the Yerkes telescope, both from his own experience and the certificate of Prof. Keeler; but he, too, is denied the pleasure of seeing it used under the most favourable conditions, and of hearing expressed the full satisfaction of those astronomers in whose hands the telescope is placed.

It is impossible to disconnect the life of Alvan G.

Clark from that of the firm with which he was associated throughout his life. It would be ungenerous to deny him his share in the success that has attended the use of such astronomical triumphs as the Washington telescope, the Pulkova, or the Lick, because they were completed in his father's lifetime. His practical participation in the work of the firm as far back as 1862, is attested by his discovery of the companion of Sirius in the course of the optical trials to which he was submitting the first large telescope the firm had constructed. Here his capacity to use a telescope is shown as effectually as he afterwards demonstrated his power to make one, and though the opportune discovery may have done much to strengthen the reputation of the firm, it did not tempt him to join the ranks of astronomical observers in preference to those of the practical optician. Possessed with the tradition of the workshop, and inheritor of his father's skill and experience, he has been content to supply the means for others to use, and in this way has rendered no mean service to astronomical science. None of those who have won an acknowledged position for accurate or for delicate work by means of the instruments the famous house of A. Clark and Sons has placed in their hands, would deny the obligation they are under to those who have devoted themselves freely and unselfishly to secure the best that art can devise, or skill and patience execute. In precisely the same manner Mr. Clark would acknowledge his indebtedness to those who have supplied him with the glass, out of which he has constructed those lenses, wherewith he has broken the record of all previous efforts in the same direction. The house of Feil, among others, has rendered him the same kind of service that he has rendered to astronomy—services that are not covered by a mere monetary payment. When we hear of the discovery of some minute speck of light, and admire the skill and dexterity of manipulation of the astronomer who has added another fact to the history of observational astronomy, it is well to remember all the causes that have contributed to his success, not to rob him of his deserved popularity and reputation, but to remind ourselves of the intimate connection pervading many branches of science and industry.

We have alluded to some of the large telescopes in which the reputation of the son is worthily joined with that of the father. We may recall another, the Bruce photographic telescope, whose successful figuring rests entirely with the younger Clark. Here the difficulty of construction was much increased by the fact that the final focal length of the combination was agreed upon between the contracting parties, and that very considerable accuracy was demanded in maintaining the original agreement. Mr. Clark triumphed over all difficulties, we believe, to the complete satisfaction of Prof. Pickering, and, if we correctly understood Mr. Clark, without the assistance of the method of "pilot" glasses or small objectives, constructed of similar glass and of like curves to those intended to be used in the construction of the finished lenses.

America has lost, perhaps, her ablest practical optician. Others starting with his experience and assisted by a lavish generosity will no doubt in time surpass his masterpieces; but his loss is a great one, and at this particular juncture will be keenly felt in the new Chicago Observatory.

NOTES.

THE sum of 297,000 francs has been subscribed for the Pasteur statue which is to be erected in Paris. M. Falguières has been commissioned to design the statue.

AT the meeting of the Paris Academy of Sciences last week, it was announced that subscriptions amounting to twenty-five thousand francs had been collected in Russia towards the fun for the erection of a statue of Lavoisier, and that this sum had been forwarded to the Academy.

THE International Postal Union has decided that natural history specimens and objects for scientific collections, shall be regarded as samples, and charged at the rate of a halfpenny for every two ounces.

WE learn from the *Bulletin* of the Botanical Society of France that it is intended to recognise in perpetuity the services rendered to viticulture in France by the late botanists, M. P. Duchartre and M. F. Laforgue, by placing commemorative marble plates on the houses where they were born, both in the neighbourhood of Béziers.

IT is stated in *Science* that Miss Catherine W. Bruce, of New York City, has again shown her great interest in astronomy by sending Prof. J. K. Rees, Director of the Columbia University Observatory, a cheque for fifteen hundred dollars. The money is to be used in publishing the observations and reductions for "Variation of Latitude and the Constant of Aberration," made by Profs. Rees and Jacoby and Dr. Davis.

DR. G. SANARELLI delivered a lecture at Montevideo on Thursday last, upon the etiology and pathogenesis of yellow fever, with special reference to the yellow fever bacillus discovered by him (see NATURE, February 18, vol. lv. p. 370). There was a very large attendance at the lecture, including a number of scientific delegates from all parts of South America, the members of the Diplomatic Body, and the principal authorities. Dr. Sanarelli confirmed his previous announcement that the cause of yellow fever is a bacillus named by him icteroid, which is rarely found either in the blood of yellow fever patients or in their bodies after death, because it easily disappears. Dr. Sanarelli said that he would shortly make experiments in preventive vaccination, and hoped to discover a curative serum.

THE Council of the Royal Society of Edinburgh have awarded the following prizes:—The Gunning Victoria Jubilee Prize for 1893-96 to Mr. John Aitken, for his brilliant investigations in physics, especially in connection with the formation and condensation of aqueous vapour; the Keith Prize for 1893-95 to Dr. Cargill G. Knott, for his papers on the strains produced by magnetism in iron and in nickel; the Mackdougall-Brisbane Prize for 1892-95 to Prof. John G. M'Kendrick, for numerous physiological papers, especially in connection with sound; the Neill Prize for 1892-95 to Mr. Robert Irvine, for his papers on the action of organisms in the secretion of carbonate of lime and silica, and on the solution of these substances in organic juices. The prizes will be presented by Lord Kelvin at the last meeting of the session, July 5.

WE regret to announce the following deaths:—Dr. Matthew Charteris, professor of materia medica in Glasgow University; Mr. Alvan Clark, the well-known manufacturer of lenses for telescopes; Prof. Dr. R. Fresenius, the distinguished chemist; Mr. Ney Elias, who won the gold medal of the Royal Geographical Society about twenty-five years ago, for his journey from Pekin to St. Petersburg, and since then explored a part of the desert of Gobi, and traversed the Pamirs; Rev. Alexander Freeman, a Fellow of the Royal Astronomical, Mathematical, and Physical Societies, and deputy for the Plumian Professor of Astronomy at Cambridge in 1880-82; the distinguished Austrian metallurgist, Prof. Peter von Tunner, at the age of eighty-nine. In 1875 he was elected an honorary member of the Iron and Steel Institute, and in 1878 received from that society the Bessemer Gold Medal in recognition of his important discoveries connected with the metallurgy of steel.

A VERY severe shock of earthquake was felt at Calcutta, at 5 o'clock last Saturday afternoon, June 12. It is stated that, from first to last, the disturbances continued for fully five minutes. Few houses escaped damage of some description, and many are in ruins. Many church towers and spires collapsed, and most of the public buildings were badly damaged by the disturbances. Reuter's agency reports that the area affected by the earthquake was very extensive. Telegrams received from Simla, Agra, Bombay, Manipur, and from places far down in the Central Provinces, report that a shock was felt almost at the same time as the earthquake occurred at Calcutta. The shock appears even to have left its record on seismometers on this side of the earth. Prof. Milne obtained at Newport, Isle of Wight, on Saturday morning, a seismographic diagram of an earthquake of unusual magnitude. It began at about 11.30 a.m., and lasted three hours. Further, a Reuter telegram from Paris states that the seismograph at Grenoble registered an earth tremor at 11.28 on Saturday morning. Both these records evidently refer o the Calcutta earthquake.

PRESIDENT MCKINLEY has transmitted to the Senate the report on forestry made by the Committee of the National Academy of Sciences at the request of the Secretary of the Interior. The following general scheme of administration of forest preserves is submitted:—A forestry bureau under a director, who is to be president of an advisory board, consisting of himself, an assistant director, and four forest inspectors. It also provides that the bureau shall have a disbursing officer, clerks, and legal advisers; twenty-six head foresters, twenty-six assistants, to constitute a permanent corps; two hundred rangers and various assistant rangers, the salary roll calling for an annual appropriation of 250,000 dollars, with preference of appointment to West Point graduates. The Legislature of the State of New York at its recent session granted one million dollars for the purchase of forest preserves in the Adirondachs; and a surveyor has just been appointed to survey the lands about Indian Lake, in order to acquire them for the State under this Act.

THE great anthropological expedition sent out by President Morris K. Jesup, of the American Museum of Natural History, left New York for British Columbia a few days ago, in charge of Dr. Franz Boas, curator of the anthropological section of the museum. His associate, Mr. Harland J. Smith, preceded him, and Dr. Livingstone Farrand, of Columbia University, accompanies him. The headquarters of the expedition will be situated in British Columbia, where about thirty Indian dialects are spoken. The language and habits of the Indians will be carefully studied, and elaborate anthropometrical observations made. Mr. Smith will engage in archæological researches in the southern portion of the territory, and several other parties will be scattered throughout British Columbia. An expedition to Alaska is contemplated for next spring; also, at some time in the near future, an expedition to Southern Siberia. All this work is under the general supervision of Prof. F. W. Putnam, though he will not take the field in person, at least for the present; the field work being under the direction of Dr. Boas.

IT has been briefly announced that next year Captain Sverdrup proposes to take the *Fram* up Smith Sound to the north-west coast of Greenland for the purpose of prosecuting exploration in that direction. Though Dr. Nansen will not accompany the expedition, the *Times* states that there is reason to believe that he is taking an active share in the direction of the expedition. The object will be to penetrate north through Smith Sound and Robeson Channel as far north as possible along the north-west coast of Greenland. An attempt will be made to discover how far Greenland extends northward, and to survey the north-west, north, and north-east coasts. In short, one prime object will be to complete the exploration of the Greenland coast, a considerable extent of which is still quite unknown.

LIEUT. PEARY has been detached from duty at the Brooklyn Navy Yard, and granted five years' leave of absence in order to enable him to prosecute his Arctic researches. He expects to begin the first trip on July 10, sailing from Boston, and will be away three or four months. Prof. C. H. Hitchcock, of Amherst, and Prof. Geo. H. Barton, of the Massachusetts Institute of Technology, will accompany him, and also probably a party from Yale. The route will be from Boston to Sydney, U.S., thence through the Gulf of St. Lawrence and the Belle Isle Straits to Resolution Island and the Greenland coast, then along the coast 1200 miles to Melville Bay. The scientific parties will be landed on the way, and picked up by the ship on its return trip in September. The main object of this trip is to prepare for a longer one of three or four years to be undertaken next year, and to attempt to reach the Pole by gradual approaches, and colonising Eskimos in high latitudes. Lieut. Peary states that he is assured of funds sufficient to prosecute the work for five years if need be, but the name of the donor is withheld. The scheme, however, has the endorsement of the American Geographical Society and the American Museum of Natural History.

THE results of a preliminary study of the conditions which exist in highly rarefied media under discharges of electricity are described, by Prof. John Trowbridge, in a paper entitled "The Energy Conditions necessary to produce the Röntgen Rays" (*Proc. Amer. Acad. of Arts and Sciences*, vol. xxxii. No. 14, April 1897). It appears from the experiments "that the discharge in a Crookes' tube, when on the point of emitting the Röntgen rays most intensely, is an oscillatory one, and that each discharge encounters a resistance less than five ohms. An estimate of the great amount of energy thus developed in an exceedingly small interval of time can be obtained if we suppose that Ohm's law holds for individual oscillations. This reservation is an important one, for the investigations I have described in this paper show that a discharge of six inches in length encounters no more resistance during its oscillations than one of two inches in length. In popular language, it can be maintained that a discharge of lightning a mile long encounters no more resistance than one of a foot in length. Ohm's law does not hold good for electrical discharges in air and rarefied gases. It is well known that a voltaic arc can be started in a vacuum. My experiments lead me to believe that in every case the arc is started by a spark which breaks down the medium, and the arc follows. I am led to believe that electrical oscillations are of the nature of voltaic arcs, and that the discharges in Crookes' tubes are voltaic arcs. I am thus forced to the conclusion that under high electrical stress the ether breaks down and becomes a good conductor."

DR. H. H. HILDEBRANDSSON, Director of the Meteorological Observatory at Upsala, has recently communicated to the Royal Swedish Society of Sciences the results of an important investigation upon the "Centres of action of the atmosphere," or the regions at which are situated the mean barometric maxima and minima. The monthly differences of the pressure of the air from the mean, as being the principal meteorological element, were calculated for the years 1875–84 at sixty-eight stations, distributed as widely as possible over the surface of the globe; the mean differences were then plotted upon monthly charts. The results obtained from the lines of equal differences show: (1) That the differences are greater in winter than in summer, and increase from the equator towards the polar regions, and also that the barometrical variations at certain localities, *e.g.* at the Azores and in the vicinity of Iceland, are

almost always opposite in sign, especially when the figures are large. (2) That the greatest differences are found in January and July in the vicinity of Greenland and Iceland on the one hand, and to the north of Russia, between the White Sea and St. Peter burg, on the other. The discussion seems to establish the fact that a kind of oscillation exists at all places in the pressure of the air between a centre of action of high pressure and another adjacent centre of low pressure. The author states that a closer study of these relations promises to lead to practical results for the prediction of weather for long periods.

THE current number of the *Annales de l'Institut Pasteur* contains M. Pottevin's annual report for 1896 on the anti-rabic inoculations conducted during the past year at the Paris Pasteur Institute. The number of persons treated was 1308, less than in any previous year since the Institute was opened. This diminution is attributable to the fact that patients, instead of going to Paris from all parts of the country, undergo the inoculations at the institutes now established at Lille and Marseilles; also similar institutes have been founded in Algiers and Turin, districts which formerly sent considerable numbers of cases to Paris. During the ten years which have elapsed since the opening of the Paris Institute, 18,645 persons have been treated there, and an interesting table is appended showing the nationality of the patients, from which it appears that England contributed no less than 870 individuals, and more than any other country; Belgium coming next, with 429. In some of the departments of France cases of rabies have steadily diminished, thanks to the energetic measures taken by the local authorities; whilst in others, where less vigorous steps have been taken to guard against its dissemination, the number of cases has increased. It is in the southern districts of France that, M. Pottevin tells us, "possess the sad distinction of containing the largest number of bitten persons, and of paying the most dearly for disobedience to the laws of the sanitary police."

IN north latitude 70° 40′ 11″·3, where the most northerly town in the world—namely, Hammerfest—is situated, there is a monument which was visited by most of those who went to Norway to obtain a view of the total solar eclipse. This monument consists of a fine granite pedestal and pillar supporting a large terrestrial globe made of copper, and was placed there to commemorate the completion of a grand piece of surveying work. The primary object of this survey was, as Mr. Fowler writes in an interesting article in *Knowledge* (June), the measurement of the earth, and to provide a permanent mark in order that the measurements may be repeated at any future time if considered desirable. Without entering into the details of a trigonometrical survey, and how a triangulation is accomplished, we will limit ourselves to the inscription, written in Latin and Norwegian, on the pillar, referring the reader to the article in question for details. "The northern termination of the arc of meridian of 25° 20′ from the Arctic Ocean to the river Danube, through Norway, Sweden and Russia, which, according to the orders of His Majesty King Oscar I., and the Emperors Alexander I. and Nicholas I., and by uninterrupted labours from 1816 to 1852, was measured by the geometers of the three nations."

PROF. P. TACCHINI, of Rome (*Atti dei Lincei*, vi. 9), describes a remarkable thunderstorm which passed over Italy on April 24, in which the rain was mixed with sand and seeds of the *caroub* that had evidently been transported from Africa.

IN a preliminary note published in the *Rendiconto della R. Accademia delle Scienze fisiche e Matematiche* (Naples), Dr. R. V. Matteucci and Dr. E. Giustiniani announce the discovery for the first time of the element selenium among the products of the "fumaroli" of Vesuvius. Dr. Matteucci has also completed a brief but accurate investigation of the dynamical phenomena connected with the eruption of 1895, of which he gives an account in the same journal.

FROM a series of investigations on the effect of cutaneous excitations on the formation of red blood-corpuscles, Prof. H. Kronecker and Dr. A. Marti, writing in the *Atti dei Lincei*, draw the following conclusions: (1) Feeble irritations of the skin promote the formation of red blood-corpuscles, but modify the formation of hæmoglobin in different ways. (2) Strong irritations of the skin determine a diminution of the number of red corpuscles, and, in a minor degree, of the hæmoglobin contained in the blood. (3) Darkness diminishes the number of blood-cells; after about a fortnight, a minimum is reached which is followed by a limited increase. (4) Continued exposure to intense light (even at night with electric light) induces the formation of red blood corpuscles, and also, in a lesser degree, of hæmoglobin.

A RÖNTGEN Society has been formed, with Prof. S. P. Thompson as the president. The intention of the founders is that the Society shall occupy a position between those devoted purely to medicine, to physics, or to photography. Some of the members will study the sources of the Röntgen rays, others the applications; some the induction coils, others the tubes and the various forms and adaptations of the apparatus used in the production of the rays. Röntgen photography has been found serviceable in so many branches of scientific investigation that the Society appeals to a large constituency for support. It should be the means of increasing the efficiency and applications of the rays, and should also be of assistance to surgeons and others who have entered the new field of work without previous training in physics.

To the June number of the *Strand Magazine*, and also to *McClure's Magazine*, Prof. S. P. Langley contributes an interesting illustrated narrative of his experiments with flying machines, and the development of the aerodrome to the condition in which it was able to demonstrate the possibility of mechanical flight. A description of the aerodome was given by Prof. Langley in these columns a year ago (vol. liv. p. 80, May 28, 1896), and the first successful flight of the machine was then described by Mr. Alexander Graham Bell.

ANOTHER name must be added to the long list of martyrs who have given up their lives while endeavouring to effect the conquest of the air. The latest victim is Dr. Wölfert, who had devoted many years to the problem of aerial navigation, and who claimed to have invented a navigable balloon. The Berlin correspondent of the *Times* says that Dr. Wölfert had made an arrangement with the officers of the ballooning section of the army to put his invention to a practical test at Tempelhof on Saturday last. The officers and a number of persons interested in aerial navigation assembled to witness the ascent. The balloon was of the new cigar-shaped form. The car was a square basket made of bamboo cane, and contained a benzene motor of eight-horse power, partly constructed of aluminium, and driving at one end of the car a propeller of the same material. At the other end of the car was a so-called helm, consisting of bamboo staves covered with linen sails. The balloon had already been tested on several occasions, and was said to have attained a very high rate of speed against the wind. Dr. Wölfert was accompanied in his ascent by a mechanic named Knabe. At first the balloon ascended steadily and began to make good progress against the wind in the direction of the suburb of Rixdorf, to reach which and to return to Tempelhof was the task set himself by its inventor. Suddenly, however, when the balloon was sailing at a height of about 1000 feet, flames shot up from the car and the balloon exploded with a loud report and was precipitated, a burning mass, into a wood-yard below. The

mounted officers hurried to the spot, and, after the flames had with great difficulty been partially extinguished, the mutilated remains of Dr. Wölfert and his companion were found amidst the ruins of the car. It is believed that the valve of the balloon was opened with the intention of descending, and that the gas, in escaping from the balloon, became ignited by the benzene.

ALL who work for the advancement of natural knowledge have reason to be grateful to the Smithsonian Institution. Under the administration of this renowned organisation come the U.S. National Museum, the Bureau of Ethnology, the Bureau of International Exchanges, the National Zoological Park, and the Astro-physical Observatory—all of which have largely contributed to the progress of science. By the exchange service the operations of the Institution extend almost to the ends of the world. How immense this branch of the work now is may be gathered from the fact that more than 24,000 correspondents are upon the exchange lists, about eleven thousand being establishments and thirteen thousand individuals. The correspondents are distributed in nearly four thousand different places, from Disco, Greenland, in north latitude 70°, to Port Stanley, Falkland Islands, in latitude 50° S.; and they extend east and west so as practically to embrace the earth. The distribution of the correspondents is indeed proportional to the spread of civilisation, and the educational status of Spain as compared with France, or China in comparison with Japan, can be rightly inferred from their relationships with the Smithsonian Institution alone.

ANOTHER work for which the Smithsonian Institute deserves the gratitude of men of science is the general appendix now printed with the Report of the Secretary. This appendix preserves for us year by year a number of very valuable papers, covering a considerable range of scientific investigation and discussion. The collection of carefully selected contributions usually contains the most important and interesting articles and addresses which were published during the year covered by the Report in which they are included. The volume just received contains thirty contributions of this character, gathered from the published literature of 1895. There are several papers which won prizes or commendation in the Hodgkins Prize Fund competition; addresses delivered at the Ipswich meeting of the British Association by Prof. W. A. Herdman and Mr. W. T. Thiselton-Dyer; a translation of a discourse by Prof. W. Ludwig von Graff on "Zoology since Darwin," and other translations from German and French journals; several papers on American archæology; a translation of the address delivered by the late M. Jules Simon at the centenary celebration of the Institute of France; a paper on science in early England by Mr. C. L. Barnes; a paper on the plan of research in education, contributed to *Science Progress*, by Dr. H. E. Armstrong; and a memorial address on Huxley, by Prof. Theodore Gill. These are but a few of the subjects of the reprinted publications; but they suffice to show the comprehensive character of the collection, and will serve to call attention to a veritable storehouse of information.

"THE ELECTRICIAN" Company are about to issue a work by Mr. W. Clark Fisher on the "Potentiometer and its Adjuncts," being a description of a universal system of electrical measurement.

MR. A. W. BENNETT has been appointed by the Council of the Royal Microscopical Society editor of the Journal of the Society, in succession to Prof. F. J. Bell.

THE Geological and Natural History Survey of the Chicago Academy of Sciences has issued its first "Bulletin," consisting of a monograph of the Lichen-flora of Chicago and its vicinity, by Mr. W. W. Calkins.

M. J. CARDOT (Stenay, Meuse, France) is about to publish a catalogue of all the species and varieties of *Sphagnum* or bog-moss, with the synonymy and geographical distribution of each species and variety. It will comprise 215 species, nearly 600 varieties, and more than 500 synonyms.

A TYPE-HERBARIUM of Lichens and a lichenological library have been instituted at Chambésy, near Geneva, under the direction of the curator of the Herbier Boissier. In memory of a late distinguished lichenologist, it will be known as the "Salle Müller-Aargau."

MESSRS. WHITTAKER AND CO. will shortly publish a volume on "Organic Chemical Manipulation," by Dr. J. T. Hewitt. The first part of the book will give an account of the methods adopted in organic analysis and the determinations of molecular weight, the second part being devoted to a typical set of organic preparations, systematically arranged and intended to give an idea of the methods adopted in organic work.

THREE publications from three of our public schools have been received during the past few days. From Harrow School has come the second volume of "Harrow Butterflies and Moths," by J. L. Bonhote and Hon. N. C. Rothschild. The first volume of this praiseworthy work has already been noticed in NATURE (vol. lii. p. 388). The present volume includes the Macro-lepidoptera not described in the former volume, and eight of the Pterophoridæ recorded from the Harrow district. The locality, time of appearance, and distinguishing features of the different species are noted; so that the volume will prove of service to collectors, as well as a record of permanent value to entomological science.—The Rugby Natural History Society have just issued their report for 1896. The papers printed in the report are on the Macro-lepidoptera of Hertfordshire, from personal observation, by H. W. Blathwayt; Lichens, by R. A. Worthington; the Aboriginals of Australia, by C. Ansted; and Photomicrography, by K. Lucas. We are glad that the Society is able to give evidence of its vitality; for we regard the expeditions made by the members, and the encouragement given to individual observation, as of the highest educational value.—The report of the Marlborough College Natural History Society is even more complete than that from Rugby. It contains papers by E. Meybrick, on the vertebrate animals (except birds) of the Marlborough District, the cretaceous fossils of the district, and botanical classification, and also a paper on acids, by R. G. Durrant. The Society appears to be in a very flourishing condition, and the reports of the various sections testifies to commendable enthusiasm of the members. A particularly interesting feature is the anthropological report containing statistics of weights and measurements of members of the school.

THE additions to the Zoological Society's Gardens during the past week include two American Flying Squirrels (*Sciuropterus volucella*) from North America, presented by Miss Lucy Sanderson; a Grey Squirrel (*Sciurus griseus*) from North America, presented by Mr. D. S. Millar; fourteen Common Chameleons (*Chamæleon vulgaris*) from Egypt, presented by Dixon Bey; two Eyed Lizards (*Lacerta ocellata*) from Southern Europe, presented respectively by Lieut.-Colonel Willoughby Verner and Mr. G. K. Gude; three Common Squirrels (*Sciurus vulgaris*), British; an Eroded Cinixys (*Cinixys erosa*) from West Africa, purchased; four Humboldt's Penguins (*Spheniscus humboldti*) from Western America, received in exchange; a Thar (*Capra jemlaica*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW SOUTHERN VARIABLE STARS.—During the past few years Prof. Kapteyn has been obtaining the negatives for the Cape Photographic *Durchmusterung*, but, owing to great pressure of work at the observatory, a minute examination of the plates could only until quite recently be made. As a result of such a search several new variable stars have been discovered; and if this examination had been commenced earlier, there is little doubt that five other variables discovered independently would have been credited to the Cape Observatory. The list of new variables now published by Dr. Gill (*Astr. Nachr.*, 3426) includes four well-marked variables, their positions for 1875 and magnitudes being given in the following table. The range of magnitude, as given by the plates examined, is shown in the third column.

α (1875·0) h. m. s.	δ (1875·0) ° ′	Range of magnitude.	
4 50 56	−21 24·9	9·25— 9·8	Nov. '95 and Feb. '96
8 41 3	−50 6·4	9·6 —10·0	Jan.–April '96
9 28 41	−36 3·8	8·8 — 8·9	May 14, 28, '90
		8·7 — 9·6	Feb. 22, 24, and March 7, '96
12 2 55	−44 43·7	8·95 – 9·75	March '96

The same communication also refers to stars of the 9th magnitude, or brighter, which are contained in the Cordova *Durchmusterung*, but are missing, or barely visible, in the Cape plates. The variability of five other stars has in this way been established.

THE 1897 MAXIMUM OF MIRA CETI.—Prof. J. A. C. Oudemans communicates a paper by Dr. Nyland, of Utrecht, who carefully observed the variable Mira Ceti from August 5, 1896, to March 10, 1897, although as he states the weather restricted his observations to a great extent. On the whole, however, the observations were fairly distributed over this period, with the result that a very good curve could be drawn through the points when laid out on millimetre paper. The curve which is included in the communication (*Astr. Nachr.*, No. 3426) indicates that on September 2, 1896, this star was at its minimum brightness, 8·50 mag.; while on January 11, 1897, it had risen to a maximum, namely 3·70 mag. These magnitudes would correspond to 8·8 and 3·5 on the scales of Schönfeld and Argelander. This further stated that the magnitude at this period of maximum was very small, in fact among the fourteen observed maxima in the years 1840-1859 only one was observed (1847 November 16) that was dimmer than that of 1897.

COMET DENNING 1894 I.—Prof. Schulhof compares (*Bulletin Astronomique*, Tome xiv. p. 168) the observed places of this comet with those given by the ephemerides. Using his second system of elliptic elements (*Astr. Nachr.*, No. 3231) he finds that the corrections to the ephemerides is very considerable for the five last observations made at Nice. He has then employed his third system of elements (*Astr. Nachr.*, No. 3236) for the representation of these observations, but still this does not reduce the differences very considerably. Prof. Schulhof finally formed his five normal places and represented them by the fourth system of elements (*Astr. Nachr.*. No. 3276.) In this way he formed a table giving the corrections to be applied to the provisional ephemerides and the deduced positions. The elements he finally uses are, as he says, probably a little nearer the truth than those of M. Lamp (*Astr. Nachr.*, 3278). With regard to the relation between Brorsen's Comet and that of the one in question, M. Lamp showed that the two comets on January 24, 1881, passed nearly simultaneously the same point in space where their orbits coincided, namely, $l=284° 27'$, b $6= -1° 46'$, $r=5·1827$, and both he and Mr. Hind have considered this comet of Denning's as a fragment of that of Brorsen. Prof. Schulhof does not, however, seem to think this hypothesis is confirmed. The elements of the two comets, he states, are too dissimilar to allow of such an assumption, π and Ω differing by 15°, and the inclination by nearly 24°. The two velocities at the period indicated above differed by as much as three kilometres per second, and such an increase in velocity, he states, is probably too large to be caused by the shock of an explosion.

OBSERVATIONS OF MARS.—The current number of the *Bulletin de la Société Astronomique de France* (June) is devoted mainly to observations of Mars made by several well-known observers. Mr. Percival Lowell records some curious observations of the Sea of Sablier, or Syrtis Major. This marking has always been looked upon as an expanse of water or a sea; but Mr. Lowell's recent observations seem to corroborate those of Prof. W. H. Pickering, who examined this spot with a polariscope, and could detect no sign of polarisation. He says that the Syrtis Major is neither an ocean, nor a sea, nor anything analogous, but something very different, namely, a large expanse of vegetation. The changes observed in this marking in 1896 seem, at any rate, to suggest such an explanation as offered by Mr. Lowell.

The other observations included are:—Mr. R. Patxot Jubert's, made at the Observatory of Sant Feliu de Guixols Gerona (Spain); Mr. José Comas Sola's, made at Barcelona; Mr. V. Cerulli's, made at Teramo (Italy); Mr. A.-A. Wonaszer's, made at Kis-Kartal; and MM. Flammarion's and Antoniadi's, made at the Observatory of Juvisy. M. Antoniadi gives also a map of the whole surface as seen by him during the opposition of 1896, and a comparison of this with charts made at other previous oppositions is of great interest. The observations made during 1896 indicate, on the whole, that great changes take place on the planet's surface. The question of vegetation and a small water supply seems, perhaps, to account for the observed facts more than any other hypothesis yet advanced, and this explanation is in conformity with rapid seasonal changes which have recently become so apparent.

SIGNALLING THROUGH SPACE WITHOUT WIRES.[1]

IN 1884 messages sent through insulated wires buried in iron pipes in the streets of London were read upon telephone circuits erected on poles above the housetops, 80 feet away. Ordinary telegraph circuits were found in 1885 to produce disturbances 2000 feet away. Distinct speech by telephone was carried on through one quarter of a mile, a distance that was increased to one and a quarter mile at a later date. Careful experiments were made in 1886 and 1887 to prove that these effects were due to pure electro-magnetic waves, and were entirely free from any earth-conduction. In 1892 distinct messages were sent across a portion of the Bristol Channel between Penarth and Flat Holm, a distance of 3·3 miles.

Early in 1895 the cable between Oban and the Isle of Mull broke down, and as no ship was available for repairing and restoring it, communication was established by utilising parallel wires on each side of the Channel and transmitting signals across this space by these electromagnetic waves.

In the electro-magnetic system two parallel circuits are established, one on each side of a channel or bank of a river, each circuit becoming successively the primary and secondary of an induction system, according to the direction in which the signals are being sent. Strong alternating or vibrating currents of electricity are transmitted in the first circuit so as to form signals, letters and words in Morse characters. The effects of the rise and fall of these currents are transmitted as electro-magnetic waves through the intervening space, and if the secondary circuit is so situated as to be washed by these ethereal waves, their energy is transformed into secondary currents in the second circuit which can be made to affect a telephone, and thus to reproduce the signals. Of course their intensity is much reduced, but still their presence has been detected though five miles of clear space have separated the two circuits.

Such effects have been known scientifically in the laboratory since the days of Faraday and of Henry, but it is only within the last few years that it has been possible to utilise them practically through considerable distances. This has been rendered possible through the introduction of the telephone.

In July last Mr. Marconi brought to England a new plan. My plan is based entirely on utilising electro-magnetic waves of very low frequency. It depends essentially on the rise and fall of *currents* in the primary wire. Mr. Marconi utilises electric or Hertzian waves of very high frequency, and they depend upon the rise and fall of electric force in a sphere or spheres. He has invented a new relay which, for sensitiveness and delicacy, exceeds all known electrical apparatus.

The peculiarity of Mr. Marconi's system is that, apart from the ordinary connecting wires of the apparatus, conductors of very moderate length only are needed, and even these can be dispensed with if reflectors are used.

[1] Abstract of a discourse delivered before the Royal Institution. June 4, by W. H. Preece, C.B., F.R.S.

The Transmitter.—His transmitter is Prof. Righi's form of Hertz's radiator.

Two spheres of *solid* brass, 4 inches in diameter, are fixed in an oil-tight case of insulating material, so that a hemisphere of each is exposed, the other hemisphere being immersed in a bath of vaseline oil. The use of oil has several advantages. It maintains the surfaces of the spheres electrically clean, avoiding the frequent polishing required by Hertz's exposed balls. It impresses on the waves excited by these spheres a uniform and constant form. It tends to reduce the wave-lengths—Righi's waves are measured in centimetres, while Hertz's were measured in metres. For these reasons the distance at which effects are produced is increased. Mr. Marconi uses generally waves of about 120 centimetres long. Two small spheres are fixed close to the large spheres and connected each to one end of the secondary circuit of the "induction coil," the primary circuit of which is excited by a battery, thrown in and out of circuit by the Morse key. Now, whenever the key is depressed sparks pass between the small and large spheres, and since the system formed by the large spheres contains capacity and electric inertia, oscillations are set up in it of extreme rapidity. The frequency of oscillation is probably about 250 millions per second.

The distance at which effects are produced with such rapid oscillations depends chiefly on the energy in the discharge that passes. A 6-inch spark coil has sufficed through the system of spheres up to four miles, but for greater distances we have used a more powerful coil—one emitting sparks 20 inches long. It may also be pointed out that this distance increases with the diameter of the large spheres, and it is nearly doubled by making the spheres solid instead of hollow.

The Receiver.—Marconi's relay consists of a small glass tube four centimetres long, into which two silver pole-pieces are tightly fitted, separated from each other by about half a millimetre—a thin space which is filled up by a mixture of fine nickel and silver filings, mixed with a trace of mercury. The tube is exhausted to a vacuum of 4 mm., and sealed. It forms part of a circuit containing a local cell and a sensitive telegraph relay. In its normal condition the metallic powder is virtually an insulator. The particles lie higgledy-piggledy, anyhow in disorder. They lightly touch each other in an irregular method, but when electric waves fall upon them, they are "polarised," order is installed. They are marshalled in serried ranks, they are subject to pressure—in fact, as Prof. Oliver Lodge expresses it, they "cohere"—electrical contact ensues, and a current passes. The electric resistance of Marconi's relay—that is, the resistance of the thin disc of loose powder—is practically infinite when it is in its normal or disordered condition. It is then, in fact, an insulator. This resistance drops sometimes to five ohms, when the absorption of the electric waves by it is intense It therefore becomes a conductor. It may be that we have in the measurement of the variable resistance of this instrument a means of determining the intensity of the energy falling upon it. This variation is being investigated both as regards the magnitude of the energy and the frequency of the incident waves. Now such electrical effects are well known. In 1866 Mr. S. A. Varley introduced a lightning protector constructed like the tube, but made of boxwood and containing powdered carbon. It was fixed as a shunt to the instrument to be protected. It acted well, but it was subject to this coherence, which rendered the cure more troublesome than the disease, and its use had to be abandoned. The same action is very common in granulated carbon microphones like Hunning's, and shaking has to be resorted to to decohere the carbon particles to their normal state. M. E. Branly (1890) showed that copper, aluminium and iron filings behaved in the same way. Prof. Oliver Lodge, who has done more than any one else in England to illustrate and popularise the work of Hertz and his followers, has given the name "coherer" to this form of apparatus. He has much improved it. Marconi "decoheres" by making the local current very rapidly vibrate a small hammer-head against the glass tube, which it does effectually, and in doing so makes such a sound that reading Morse characters is easy. The same current that decoheres can also record Morse signals on paper by ink. The exhausted tube has two wings which, by their size, tune the receiver to the transmitter. Choking coils prevent the energy escaping. Oscillations set up in the transmitter fall upon the receiver tuned in sympathy with it, coherence follows, currents are excited, and signals made.

In open clear spaces within sight of each other nothing more is wanted, but when obstacles intervene and great distances are in question height is needed; tall masts, kites, and balloons have been used. Excellent signals have been transmitted between Penarth and Brean Down, near Weston-super-Mare, across the Bristol Channel, a distance of nearly nine miles.

It is curious that hills and apparent obstructions fail to obstruct. The reason is probably the fact that the lines of force escape these hills. Weather seems to have no influence; rain, fogs, snow and wind, avail nothing.

There are some apparent anomalies that have developed themselves during the experiments. Mr. Marconi finds that his relay acts even when it is placed in a perfectly closed metallic box. This is the fact that has given rise to the rumour that he can blow up an ironclad ship. This might be true if he could plant his properly tuned receiver in the magazine of an enemy's ship. Many other funny things could be done if this were possible. I remember in my childhood that Captain Warner blew up a ship at a great distance off Brighton. How this was done was never known, for his secret died shortly afterwards with him. It certainly was not by means of Marconi's relay.

The distance to which signals have been sent is remarkable. On Salisbury Plain Mr. Marconi covered a distance of four miles. In the Bristol Channel this has been extended to over eight miles, and we have by no means reached the limit.

It is easy to transmit many messages in any direction at the same time. It is only necessary to tune the transmitters and receivers to the same frequency or "note." Enough has been done to prove its value, and to show that for shipping and lighthouse purposes it will be a great and valuable acquisition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. R. A. Buddicom, Scholar of Keble College, has been elected to the University Biological Scholarship at Naples.

The University, in view of the visit of so many distinguished men to England for the Diamond Jubilee celebrations, has decided to confer the honorary degree of D.C.L. on Her Majesty's Premiers, amongst others, at this year's Commemoration. The following will therefore be the recipients of this honour:—The Hon. W. Laurier, Premier of the Dominion of Canada; Hon. Sir W. V. Whiteway, K.C.M.G., Premier of Newfoundland; Hon. Sir J. Gordon Sprigg, K.C.M.G., Premier of Cape Colony; Hon. G. H. Reid, Premier of New South Wales; Hon. G. C. Kingston, Premier of South Australia; Hon. Sir H. M. Nelson, K.C.M.G., Premier of Queensland; Hon. G. D. Taubman-Goldie, K.C.M.G., Governor of the Royal Niger Company; and Mr. E. H. Godkin, of New York.

The Junior Scientific Club met on June 9 and 16. Papers were read by Mr. R. R. Marett (Exeter), on the sanctions of savage morality; and by Messrs. P. Elford (St. John's) and N. E. Moss (Trinity) on artificial silks; E. H. Hunt (Balliol) and A. S. Fisher (New College).

Convocation on Tuesday unanimously passed a decree conveying the cordial thanks of the University to the Worshipful Company of Drapers for their munificent offer to erect a new building for the Radcliffe Library at the expense of 15,000*l.*

CAMBRIDGE.—Prof. Fitzgerald, of Dublin, has been appointed an Examiner for the Adams Prize, in the place of the late Mr. E. J. Stone.

The Senior Wrangler is Mr. W. H. Austin, of Trinity. Six out of the first seven Wranglers are from the same College. In Part II. of the Tripos, Messrs. Barnes and Wilkinson, of Trinity (bracketed second, 1896), and Mr. Houston, of St. John's (bracketed fifth, 1896), are placed in the first division, the Senior Wrangler of last year being in the second division. No ladies are classed as Wranglers this year.

IT is stated in the *American Naturalist* that work will soon be in full progress on the erection of a portion of the new Museum of Archæology and Palæontology, for the University of Pennsylvania. A botanical garden, covering ten acres, will be laid out around the museum. The site of the structure was ceded to the University by the city on condition that a museum of art and science, surrounded by a botanical garden, be erected on it. The portion to be erected immediately will cost not less than 500,000 dols., while the cost of the whole building will amount to 4,000,000 dols.

THE following are among recent appointments:—Dr. J. Franz, Assistant Professor of Astronomy at Königsberg, to be Director of the Breslau Observatory, and Professor of Astronomy in the University there; Dr. Frech to be full Professor of Geology in the University of Breslau; Dr. Carl Paal to be full Professor of Pharmaceutical and Applied Chemistry in the University of Erlangen; Dr. Paul Samassa to be Associate Professor of Zoology in the University of Heidelberg; Dr. Bredt, of Bonn, to be full Professor of Chemistry in the Polytechnic Institute at Aix; Dr. E. B. Copeland to be Assistant Professor of Botany in the University of Indiana; Mr. William George Hibbins, Whitworth Exhibitioner, and Research Scholar of the Mason College, Birmingham, to be additional Assistant in the Mechanical Engineering Department of the Merchant Venturers' Technical College, Bristol.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 3.—"The Sensitiveness of the Retina to Light and Colour." By Captain W. de W. Abney, C.B., D.C.L., F.R.S. Received May 10, 1897.

The author treats first of the extinction of the sensation of light on the centre of the retina. He made his reduction of the intensity of the light falling on the illuminated spot with a new piece of apparatus, which consisted of a gelatine wedge bent so as to make an annulus. He describes this wedge and its graduation, showing how its readings can be utilised, they being proportional to the logarithm of the intensity of light passing through it.

It is found that the smaller the spot of illuminated surface, the less reduction in intensity of the light is required, and that the amount of reduction of the light falling on the spot which just produces no sensation of light, is connected with the size of the spot by a simple formula, $I = x^m$, where I is the intensity and x the diameter of the spot. Further, he finds that it is the smallest diameter which governs the necessary reduction in intensity, and not the area of the illuminated surface. Having experimented with the extinction of light at other parts of the retina, he finds that it obeys the same law. Since a large and a small area having the same actual illumination appear to be of different brightness, an investigation was made of the relative luminosities of the two, and it was found that the two were connected by a very simple law.

The reduction of the intensity of a coloured ray to extinguish all colour was next measured with areas of different dimensions, and it was shown that again the intensity of the reduced light was connected with the size of the spot by a simple expression similar to that of the extinction of all light, but the exponential coefficient differed, indicating that light and colour were not connected together in the manner which might be expected.

The author then deals with the question of colour fields, and finds that all colour fields are of the same form, the extent depending solely on the illumination and the area of the surface the image of which fails on the retina. He finds that there is a connection between the intensity of the colour and the extent of the field which can be expressed by a formula, as also can the connection between the size of the spot of illuminated surface and the extent of field. He gives the curves of illumination for equal colour fields, and the curves of extent of field for every colour in the prismatic spectrum. Finally he makes an investigation into the relative sensitiveness to light of various points in the retina, and shows that there are "iso-lumes," or fields of equal sensitiveness, which appear to be of the same form as the colour fields.

He points out that there are difficulties in reconciling these results with either the Young or Hering theory of colour vision, and suggests a modification in the accepted theory of light and colour which may explain the connection between the two.

"On the Nature of the Contagium of Rinderpest." By Alexander Edington, M.B., F.R.S.E., Director Colonial Bacteriological Institute, Cape Colony.

In the following paper it is proposed to communicate to the Royal Society the results of experiments made in South Africa on the infectivity of the blood of animals affected with rinderpest. The experiments were all made on cattle kept under conditions in which accidental spontaneous infection could with certainty be excluded. These experiments had been concluded in 1896, before the arrival of Dr. R. Koch in South Africa, and their results had been communicated to him on his arrival.

(1) The blood of an animal ill with rinderpest, when taken during the febrile stage or previous to death, and injected subcutaneously or intravenously into healthy cattle, produces the typical disease—rinderpest, provided the blood is prevented from coagulating.

(2) The onset of coagulation and actual coagulation of the blood exerts a marked destructive influence on the virulence of such blood.

(3) The best method of obtaining virulent blood is to draw it aseptically from the jugular vein of an animal ill with rinderpest, and to mix it immediately with a 1 per cent. solution of citrate of potash, the latter previously well sterilised, in the proportion of 2-3 parts of blood to 1 part of citrate of potash solution. Such blood, as has been shown, remains fluid.

(4) This citrate of potash mixture of blood proves virulent in the first few days, generally not exceeding six days; after six days' keeping the virulence becomes rapidly weakened, so that after nine days the blood mixture is altogether inert.

(5) Admixture of glycerine to citrate blood does not *cæteris paribus* interfere with the virulence of such blood. Glycerine added to fresh blood does interfere with the virulence of the latter on account of the coagulation of the blood.

(6) The nasal mucus of an infected animal when used fresh and rubbed into the nostrils of normal cattle, produced in all instances typical rinderpest. We have never had a single failure in attempting to produce the disease by this means. By keeping the nasal mucus, even for a few hours, its virulence becomes markedly less.

(7) The condition of marked swelling of the lymphatic glands is one of, if not indeed the most evident pathognomic feature of the disease. The contagium exists as a primary infection in the lymphatic glands.

(8) A very mild attack of rinderpest, such as is produced by injection of blood of greatly decreased virulence, does not convey absolute immunity, this latter being produced in proportion to the severity of the attack through which the animal had passed primarily. An animal seemingly affected may have a relapse of the disease, which may go on to fatal issue or be mild in type, leading to recovery. Animals in the latter case always acquire immunity of a high degree.

Physical Society, June 11.—Mr. Shelford Bidwell, President, in the chair.—A mathematical paper was read by Mr. C. S. Whitehead, on the effect of sea-water on induction telegraphy. If a secondary circuit containing a telephone is rightly placed with respect to the field of a primary circuit traversed by an alternating current, signals may be transmitted over considerable distances. The author investigates the effect of filling the intervening space with sea-water; and, generally, the effect of a spherical conducting shell on the induction, at a point in a dielectric, due to an alternating current in a circular circuit, when the axis of the conductor passes through the centre of the shell. In the mathematical treatment, two cases are considered. (1) To find the normal magnetic induction at any point in the dielectric outside the shell when a circular circuit carrying an alternating current is placed in the dielectric inside a spherical conducting shell. (2) To find the normal magnetic induction at any point on the remote side of an infinite conducting plate, due to a circular circuit parallel to the plate. In both cases the following result is arrived at:

$$\frac{v_0}{u_0} = e^{-q\eta}$$

where v_0 is the maximum value of the normal magnetic induction at any point outside; w_0 the maximum normal magnetic induction due to the current in the primary, supposing the conducting shell or plate absent, at the same point; η the thickness of the shell or plate; and

$$q = \left(\frac{2\pi\mu p}{\sigma}\right)^{\frac{1}{2}}$$

where μ is the permeability of the conducting shell or plate; σ its specific resistance, $p = 2\pi$ times the frequency. If the frequency is 300, $p = 1885$. For sea-water, σ is taken as 2×10^{10} C.G.S. units; and $\mu = 1$. The sea-depth at the North Sand Head corresponds to $\eta = 2000$ cms. Hence, in this case, $\frac{v_0}{u_0} = \cdot 21$, or 79 per cent. is lost. Similarly, when

$\eta = 1000$, the loss is 54 per cent. The method employed in the investigation is that suggested by Lamb and Niven; the author adds an expression for Ω, the solid angle subtended by the circuit at any point, in terms of Bessel's functions. Mr. Evershed referred to some experiments of his own, from which he concluded that the author's formula gave too low an estimate of the attenuation; the discrepancy indicated that some term had been neglected. Mr. Yule doubted whether the equations given by the author were quite applicable to sea-water. There was need, apparently, of a term involving the polarisation of the medium. Mr. Heaviside communicated a criticism of the paper. It was not necessary to investigate the problem for any particular form of circuit from which the waves proceed. The attenuating factor for plane waves, due to Maxwell, was sufficient. Taking the best-known value for the conductivity of sea-water, there was no reason why the conductivity should interfere with signalling. A considerably greater conductivity must be proved for sea-water before it could be accepted that the failure of experiments on telegraphic communication with light-ships from the sea-bottom was due to that factor. It was unlikely theoretically; and Mr. Stevenson had contradicted it from a practical standpoint. For some reason, the account of the light-ship experiments had not been published, so that there was no means of finding the real cause of failure.—Mr. T. H. Blakesley read a paper on a new definition of focal length, and an instrument for determining it. The author asserts the principle that the focal length of a lens-combination is an abstract quantity, not necessarily the distance between two particular points. It is a quantity best defined in terms of some function of the two distances of object and image from their appropriate focal centres. Such a function is the magnification factor, m, the linear ratio of image to object, positive if the image is erect with regard to the object. Consider a particular pair of conjugate foci on the axis of a lens-system. Let one of these foci be at distance v from some fixed point on the axis, measured positively, in the direction of the rays. Then $\frac{dv}{dm}$ is constant, and is the focal length, f. If v_0 is the value of v when $m=0$, $v-v_0=f.m$. Let u be the position of the other focus, and u_0 its value when $m=\infty$. Then $u-u_0=f.m^{-1}$; and $\frac{v-v_0}{u-u_0}=m^2$. The last expression, m^2, may be called the "areal magnification"; it is important in determining photographic exposure. The author describes an optical bank which enables $\frac{dv}{dm}$ to be measured by a very simple operation; it gives also a record, on a paper strip, of the magnification-factor corresponding to various relative positions of object and image. Dr. S. P. Thompson said the paper was the most important contribution to geometrical optics that had appeared for many years. The introduction of the magnification function was a most useful device leading to exceedingly simple results. The important thing to measure was not so much the focal length as the reciprocal of that quantity. Dr. Chree said the photographic method at present used at Kew for determinations of focal length gave greater security than any more direct method. The colour of the light had to be taken into account. Mr. Blakesley, in replying, called attention to the use of his strip diagrams of magnification, for enlarging purposes in photography. When the magnification along some definite line was known, the focussing-cloth might almost be dispensed with.—Dr. J. A. Fleming read a paper on a method of determining magnetic hysteresis loss in straight iron strips. The author's process is based upon the use of the bifilar reflecting watt-meter. The samples of iron, large or small, in the form of straight strips are inserted in a long solenoid. The solenoid is traversed by an alternating current, and the square-roots of the mean-square values of the current are determined by a Kelvin balance. A flat bobbin of fine wire may be slid along the strip; an electrostatic voltmeter connected to the ends of this exploring coil gives the square-roots of the mean-square values of the electromotive force in that coil. From these measurements and the known dimensions of the solenoid and coil, the induction density, B, can be found at any point of the length of the strip. From these results a curve is drawn, coordinating the values of B to corresponding distances along the half-length of the strip. Assuming the hysteresis loss per cycle, per c.c. of iron, to vary as the 1·6th power of the maximum induction density, and then raising all the B ordinates to the 1·6th power, and plotting a new curve over the first, another curve is obtained which represents the variation of hysteresis loss per c.c. of iron from point to point along the half-length of strip. Now, at some point along the half-length of strip there must be a section where the induction density is B, such that the true *mean* hysteresis loss for the *whole* bar is proportional to $B_1^{1·6}$. Let this value of the induction density be called the "*effective value*," and the corresponding point in the strip the "*effective point*." Let $M·B^{1·6}$ stand for the mean ordinate of the curve representing the varying values of $B^{1·6}$ all along the half-length. Then, evidently,

$$B_1 = \sqrt[1·6]{M·B^{1·6}}$$

The following curious experimental result is found. Whatever may be the length or section of the iron strip, the point at which the actual induction density has a value equal to the "effective" value, always comes at the same proportional distance from the centre of the strip. This distance is very exactly equal to 0·56 of the half-length, as measured from the middle; or 0·22 of the whole length from one end. If, therefore, the secondary coil is placed at that spot, and the secondary voltage then observed is used to calculate the induction density, the value so obtained corresponds to the true mean value of the varying hysteresis loss per c.c. all along the strip. Mr. Carter asked whether roots other than the 1·6th gave a similar constant value of the induction density. Dr. Fleming said it seemed to be the result of accident that the 1·6th root gave a constant value for iron.—The President proposed a vote of thanks to the authors, and the meeting adjourned until June 25.

Geological Society, May 26.—Dr. Henry Hicks, F.R.S., President, in the chair.—On augite-diorites with micropegmatite in Southern India, by Thomas H. Holland, Officiating Superintendent, Geological Survey of India. This paper dealt with a series of basic dykes intersecting the pyroxene-granulites and gneisses of the Madras Presidency, and believed to be of the same age as the lava-flows of the Cuddipah system. These dykes consist essentially of augite (near hedenbergite) and a plagioclase-felspar (near labradorite), between which we find masses of micropegmatitic intergrowths of felspar and quartz, with a micro-miarolitic structure. Around the patches of micropegmatite, chemical changes have frequently taken place in the minerals of the rock. After discussing the chemical constitution of the rock, and of its various constituents, and the relation between the micropegmatite and the surrounding minerals, the author pointed out that three methods for the formation of the micropegmatite may be conceived of: (α) during the primary consolidation of the magma; (β) by secondary changes induced in the rock; (γ) by subsequent intrusion of granophyric material into the augite-plagioclase rock. In opposition to (γ), the author pointed out the entire absence of granitic intrusions in the neighbourhood. He regarded the absence of all proofs of subaerial hydration, and the remarkable freshness of the rocks as precluding the possibility of the micropegmatite having been formed by secondary change. The primary origin of the micropegmatite he believed to be proved by (1) the crystallographic continuity of its felspar with that of the normal plagioclase of the rock; (2) the mode of occurrence of the micropegmatite, filling in the angles and spaces between the augite and the plagioclase; and (3) its variation in coarseness of grain agreeing with that of the remaining two constituents of the rock. An interesting discussion took place upon the question of the primary or secondary origin of the micropegmatite in basic rocks.—The laccolites of Cutch and their relations to the other igneous masses of the district, by the Rev. J. F. Blake. The author has observed thirty-two domes of various kinds in Cutch, distributed as follows: (i.) those connected with the northern islands; (ii.) those of Wagir; and (iii.) those along the northern edge of the mainland. They are divisible into four classes: (*a*) those which are so elongated on the line joining adjacent ones that they seem to be mere modifications of anticlinals, though the supposed anticline is not really continuous; (*b*) those which lie in a line, but are not elongated in that direction, and often in no other; (*c*) those which are related to a fault, which cuts them in half; and (*d*) those which are not in any particular relation to each other, or to any other stratigraphical feature. The domes varied in degree of perfection: some were irregular, while some had the strata running in concentric circles, the outer and newer strata dipping away from the inner and older. In no less than ten of the thirty-two domes igneous bosses were found occupying the centre, and these were distributed amongst all of the above classes. The author gave reasons for maintaining that the domes were the results of intrusion of igneous rocks in the

form of laccolites, and were not anticlinal folds which have afterwards been affected by cross-folds. The domes were contrasted with igneous peaks which occurred in abundance in a different part of the area, usually at a higher horizon of the strata and at a higher level above sea. These were probably volcanic pipes through which the lava was forced and extruded at the surface. The author compared the rocks of the bosses with those of the dykes and flows. Both were principally perfectly fresh dolerites, but the former were distinguished by the presence of intergrowths of micropegmatite as the last stage of consolidation, as in the "Konga diabases." There was also among them a felsite-breccia with micropegmatite developed in the cracks. He considered that nearly all the igneous rocks of Cutch had been derived from a single magma, which in a solid condition must have contained large crystals of augite, olivine, and ilmenite in a ground-mass of lime-felspars, and have been throughout of a basic character. Such a magma originated in more than one centre.

Zoological Society, June 1.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—A communication was read from Dr. John Anderson, F.R.S., containing a water-colour drawing of the Egyptian weasel (*Mustela subpalmata*), taken from living specimens which he had recently presented to the Society's menagerie. Dr. Anderson also sent some remarks on this rare Egyptian mammal, and others were made by Mr. E C. Taylor.—A communication was read from Prof. T. W. Bridge, on the morphology of the skull in the Paraguayan Lepidosiren and other Dipnoi.—A paper on the classification of the *Thyrididæ*, a family of the Lepidoptera Phalænæ, by Sir George F. Hampson, Bart., was read. It contained short diagnoses of the twenty-six known genera (of which *Pycnosoma* and *Plagiosella* were described as new) of the group, and a list of the known species of each genus.—A second communication from Sir George Hampson treated of the classification of the *Chrysauginæ*, a subfamily of moths of the family *Pyralidæ*. Like the preceding paper, it contained diagnoses of the known genera, of which seventy-six were enumerated, and a list of the known species of each genus. Of the genera the following were characterised as new:—*Hyalosticta*, *Protrichia*, *Prionidia*, *Microzancla*, *Sarcistis*, *Monoloxis*, *Dilaxis*, *Tetraschistis*, and *Cyclopalpia*.—Dr. A. G Butler read a paper on a collection of Lepidoptera obtained in East Africa in 1894 by Mr F. Gillett. Fifty-seven species were enumerated, and the dates of the capture of the specimens were recorded.—Dr. C. I. Forsyth Major read a paper on the Malagasy genus of rodents *Brachyuromys*, and entered into the question of the mutual relation of some of the groups of the *Muridæ* (*Hesperomyinæ*, *Microtinæ*, *Murinæ*, and *Spalacidæ*) with each other and with the *Nesomyinæ* of Madagascar. The Malagasy Rodentia were considered as forming a subfamily *Nesomyinæ*, the lowest of *Muridæ*, being forerunners of the American *Hesperomyinæ*, the Old-World *Murinæ* and the *Microtinæ* (*Arvicolinæ*). One of the genera from Madagascar (*Brachyuromys*) was stated to bear close affinities to a genus of the *Spalacidæ*. Reasons were given for regarding the last-named family as only lowly-organised *Muridæ*.

CAMBRIDGE.

Philosophical Society, May 10.—Prof. Liveing, Vice-President, in the chair.—Observations on stomata by a new method, by Mr. Francis Darwin, President. The method consists in the use of "Chinese sensitive leaf," *i.e.* thin sheets of horn treated in a special manner. When a strip of this substance is placed on the stomatal surface of a leaf, it gives evidence of the condition of the stomata by its movement. If they are open, it curves away from the source of moisture; if shut, it remains stationary. By means of a simple apparatus the degree of curvature of the horn is recorded. All the ordinary experiments with stomata can be easily and rapidly shown with a hygroscope of this sort. By taking readings at regular intervals the diurnal course of the stomata can be studied; in this way it has been shown that the nocturnal closure of the stomata is a periodic phenomenon like the "sleep" of leaves. A number of observations were made on the effects of the withering of leaves on the stomata: it was shown that while the stomata of certain species simply close as the leaf withers, in others the first effect is a well-marked opening. This fact is of interest in connection with the mechanism of the stomata, since it indicates the share which the pressure of the surrounding epidermic cells has on the guard cells. It was shown that many plants open their stomata in long-continued darkness; this fact bears on the mode of action of the guard cells, since it shows that they do not (as is often assumed) lose their turgescence when the assimilation of CO_2 is prevented.—Notes on hybrid Cinerarias produced by Mr. Lynch and Miss Pertz, by Mr. Bateson. It is stated by many writers that the garden Cineraria arose as the hybrid offspring of several species of *Senecio* from the Canary Islands. This statement has been questioned by Mr. Thiselton Dyer on various grounds. The author exhibited hybrids raised from *S. cruentus*, *S. multiflorus*, and *S. Heritieri* (= *lanatus*) raised in the Cambridge Botanic Gardens by Mr. Lynch and Miss Pertz, which illustrated the very great variability which appears in the offspring of the various crosses In particular, specimens of *Heritieri* ♀ × *cruentus* ♂ and of the reciprocal cross were produced, showing excessive variability and proving how greatly the peculiar characters of *Heritieri* may be obscured in the offspring, even of the first cross. Five specimens of *multiflorus* ♀ × *Heritieri* ♂ were exhibited, each of which was exceedingly distinct from the rest. Experiments had entirely confirmed Darwin's observation that Cinerarias are self-sterile in a high degree. They hybridise, on the contrary, with great readiness. An accidental hybrid between *Heritieri* ♀ × garden Cineraria ♂ and the reciprocal were also shown, the two plants being quite unlike each other. One seedling *multiflorus* ♀ × garden Cineraria ♂ had been produced which was almost entirely female, a few anthers only appearing in later inflorescences. These experiments were to be continued; but so far as they had gone, they were entirely consistent with the view that the Cineraria was a hybrid between several species, *cruentus*, *Heritieri* and, probably, *multiflorus* being among them. The two first are named by most writers as probable parents.

PARIS.

Academy of Sciences, June 8.—M. A. Chatin in the chair.—On the periods of double integrals, and the development of the disturbance function, by M. H. Poincaré.—General theory of gradually varied conditions in the friction of liquids with vortices; formulæ of the first approximation, by M. J. Boussinesq.—Action of light upon mixtures of chlorine and hydrogen, by MM. Armand Gautier and H. Hélier. The influence of moisture upon the combination of the two gases under the action of light was first studied. When water is present the velocity with which hydrochloric acid is formed is considerably increased, this effect being probably produced by the lowering of the partial pressure of the hydrogen chloride formed. The effect produced by exposure for different periods to standard artificial light was also studied. If either gas is in excess, the reaction is much accelerated.—Observations on the limitation of chemical reactions, with especial regard to the preceding communication, by M. Berthelot.—Reply of M. Armand Gautier to M. Berthelot.—Note by M. Berthelot accompanying the presentation of his work on "Thermochimie."—A new truffle (*Terfezi aphroditis*) from the Isle of Cyprus, by M. Ad. Chatin. This truffle is characterised by its dark colour, being known locally as the black truffle. It frequently attains a very large size, one weighing 385 grams having been found in 1873.—Micrometric measures of double stars made at St. Petersburg and Domkino by Prof. S. de Glasenapp, Director of the Imperial University of St. Petersburg, by M. Loewy.—Examination of some spectra, by M. Lecoq de Boisbaudran. A reply to some criticisms of Eda and Valenta.—A Committee was appointed to present a list of candidates for the Foreign Associateship, rendered vacant by the death of M. Tchébychef.—Theoretical and practical study of the lung, its functions and diseases. Tuberculosis and its clinical cure, by M. H. Grasset.—On surfaces having the same spherical representation, by M. A. Pellet.—Remarks on a recent note of J. M. Weber, by M. E. Goursat.—On real systems of complex numbers, by M. E. Cartan.—Properties of the simple kathodic rays. Relations with simple electric oscillations, by M. H. Deslandres. An electrified body, interposed in the path of a kathode ray, causes an enlargement of the shadow, the kathode bundle being divided up into several distinct and unequally deviated bundles. These bundles are called simple kathodic rays, and it is shown that they correspond to simple electric oscillations.—On the atomic weight of cerium, by MM. Wyrouboff and A. Verneuil. Having shown in a preceding paper that it is possible to prepare cerium oxide in a state of high purity, this specimen has been utilised to fix the atomic weight of the metal. The sulphate was carefully purified from free sulphuric acid by repeated precipitation with alcohol or by careful ignition, and the atomic weight determined by

three methods, namely, from the loss of water of the hydrated sulphate at 250° (92·70), from the ratio C_3O_4: hydrated salt (92·83), and from the ratio C_3O_4: dry salt (92·87), the mean result being about 92·7.—On the heat disengaged by the addition of bromine to some unsaturated substances, by MM. W. Louguinine and Iv. Kablukov. The unsaturated substances, for which results are given, include allyl chloride, ethyl allyl ether, allyl acetate, crotonic aldehyde, mesityl oxide and cinnamic alcohol.—Combinations of phenylhydrazine with metallic bromides, by M. J. Moitessier. Compounds of phenylhydrazine with the bromides of zinc, cadmium and magnesium are described.—On a menthoglycol, by MM. Ph. Barbier and G. Leser.—Chemical study on the culture of *Cattleya*, by MM. Alex. Hébert and G. Truffaut.—The use of aluminium vessels, by M. Balland. A method of treatment is described which permits of the rapid examination of aluminium water-flasks and other vessels used for military purposes.—The bacteria of boghead cannel, by M. B. Renault. The presence in boghead coal of an extremely small micrococcus is proved, to the chief of which the name *Micrococcus petrolei* is given.—Study of the infectious lesions of the bubonic plague, by M. Gustave Nepveu.—Researches on the Ostioles, by M. J. J. Andeer.—On the mechanical impossibility of the geometry of Lobatschewsky, by M. Jules Andrade.

DIARY OF SOCIETIES.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.—An Experimental Research upon Cerebro-Cortical Afferent and Efferent Tracts: Prof. Ferrier, F.R.S., and Dr. Turner.—On the Relative Behaviour of the H and K Lines of the Spectrum of Calcium: Dr. and Mrs. Huggins.—(1) Further Observations of Enhanced Lines. (2) The Total Solar Eclipse of August 9, 1896. Report on the Expedition to Kiö Island. (3) On the Classification of the Stars of the δ Cephei Class: J. Norman Lockyer, F.R.S.—On the Action exerted by certain Metals and other Substances on a Photographic Plate: Dr. W. J. Russell, F.R.S.—Stress and other Effects produced in Resin and in a Viscid Compound of Resin and Oil by Electrification: J. W. Swan, F.R.S.—On Lunar and Solar Periodicities of Earthquakes: Prof. A. Schuster, F.R.S.—Kathode Rays and some Analogous Rays: Prof. S. P. Thompson, F.R.S.—And other Papers.

LINNEAN SOCIETY, at 8.—On the Distribution of *Primula elatior*, Jacq.: Miller Christy.—On the Acari collected by Mr. H. Fisher, Naturalist of the Jackson-Harmsworth Polar Expedition, at Cape Flora, Northbrook Island, Franz-Josef Archipelago, in 1896: A. D. Michael.—Further Observations on Stipules: Sir John Lubbock, Bart., F.R.S.—On Minor Tension Lines between Plant Formations: Prof. Conway Macmillan.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Reduction of Perthiocyanic Acid: F. D. Chattaway and H. P. Stevens.—Molecular Refraction of Dissolved Salts and Acids, Part II.: Dr. J. H. Gladstone, F.R.S., and W. Hibbert.—On a Space Formula for Benzene: Prof. J. Norman Collie, F.R.S.—On the Production of some Nitro- and Amido-oxypicolines: Dr. A. Lapworth and Prof. J. Norman Collie, F.R.S.—The so-called Hydrates of Iso-propyl Alcohol; Dr. T. E. Thorpe, F.R.S.—The Carbohydrates of the Cereal Straws: C. F. Cross, E. J. Bevan, and C. Smith.—Further Experiments on the Absorption of Moisture by Deliquescent Substances: H. Wilson Hake.

MINERALOGICAL SOCIETY, at 8.—On Blödite from the Punjab: F. R. Mallet.—On Monazite and Xenolime in European Rocks: Orville A. Derby.—On the Identity of Sundtite and Webnerite: G. T. Prior and L. J. Spencer.

FRIDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Sub-Oceanic Changes: Prof. John Milne, F.R.S.

SATURDAY, JUNE 19.

GEOLOGISTS' ASSOCIATION—Excursion to Leighton Buzzard. Director: A. C. G. Cameron. Leave Euston, 9.10 a.m.; arrive Leighton, 10.47 a.m.

MONDAY, JUNE 21.

VICTORIA INSTITUTE, at 4.30.

TUESDAY, JUNE 22.

ROYAL STATISTICAL SOCIETY, at 5.—Annual General Meeting.

WEDNESDAY, JUNE 23.

GEOLOGICAL SOCIETY, at 8.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY, at 5.—A New Theory of the Earth's Magnetism; Mr. Sutherland.—Experiments in Critical Phenomena; Dr. Kuenen.—On the Attenuation of Electric Waves in Wires: Dr. Barton.—On the Steady Motion of an Electrified Ellipsoid: G. F. C. Searle.

SATURDAY, JUNE 26.

GEOLOGISTS' ASSOCIATION.—Excursion to Red Hill and Merstham (New Railway). Directors: Dr. G. J. Hinde, F.R.S., and W. Whitaker, F.R.S. Leave Cannon Street Station (S.E.R.) at 1.35 p.m.; arrive at Red Hill, 2.21 p.m.

LONDON GEOLOGICAL FIELD CLASS.—Excursion—Aylesford to Maidstone. Lower Greensand. Leave Cannon Street, 2.37; arrive Aylesford, 4.9.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—In Garden, Orchard and Spinney, Phil Robinson (Isbister).—The Dolmens of Ireland: W. C. Borlase, 3 Vols. (Chapman).—The Woodland Life: E. Thomas (Blackwood).—The Collected Mathematical Papers of Arthur Cayley, Vol. xii. (Cambridge University Press).—Électro-Métallurgie: A. Minet (Paris, Gauthier-Villars).—Grundprobleme der Naturwissenschaft: Dr. A. Wagner (Berlin, Gebrüder Borntraeger).—Introduction to Philosophy: Prof. O. Külpe, translated by W. B. Pillsbury and E. B. Titchener (Sonnenschein).—The Fertility of the Land: Prof. I. P. Roberts (Macmillan).—Human Embryology: Prof. C. S. Minot (Macmillan).—The Psychology of the Emotions: Prof. Th. Ribot (Scott).—Grundriss der Entwickelungsmechanik: W. Haacke (Leipzig, Georgi).—Nouvelle Étude sur les Tempêtes, &c.: H. Faye (Paris, Gauthier-Villars).—Life in Early Britain: Prof. B. C. A. Windle (Nutt).

PAMPHLETS.—L'Ora Esatta Dappertutto: Dr. M. Rajna (Milano, Hoepli).—On the Origin of the European Fauna: Dr. R. F. Scharff (Dublin, Ponsonby).—Epistolæ quas per Annos a 1596 ad 1601: Tycho Brahe et Oligerus Rosenkrantzius (Havniae).

SERIALS.—Proceedings of the Physical Society of London, June (Taylor).—Geographical Journal, June (Stanford).—Journal of the Asiatic Society of Bengal, Vol. lxv. Part 2, Nos. 3 and 4; and Part 3, No. 1 (Calcutta).—American Journal of Science, June (New Haven).—Abhandlungen zur Physiologie der Gesichtsempfindungen aus dem Physiologischen Institut zu Freiburg i. B., Erstes Heft (Hamburg, Voss).—Aeronautical Journal, 1897. No. 3 (Boston, Clarke).—Atti della Fondazione Scientifica Cagnola della sua Istituzione in Poi, Vol. xiv. (Milano).—Memoire del R. Istituto Lombardo di Scienze e Lettere, Vol. xx., xi. sella, serie iii. Fasc. 1–4 (Milano, Hoepli).—Journal of the Chemical Society, June (Gurney).—Bulletin of the American Mathematical Society, May (New York, Macmillan).—Himmel und Erde, June (Berlin, Paetel).—Journal of the Franklin Institute, June (Philadelphia).—American Naturalist, June (Philadelphia).—Transactions of the American Microscopical Society, Vol. xviii. (Buffalo, Brown).—McClure's Magazine, June (New York, McClure).

CONTENTS.

THURSDAY, JUNE 24, 1897.

1837—1897.

THERE has been one feeling in the minds of the inhabitants of Britain, and of Greater Britain, during the last week, which has thrown all others into the shade—a feeling of intense patriotism and loyalty to the Queen, mixed with a deep reverence for her personal qualities. It is this feeling which has brought representatives to our shores from every part of the greatest empire which so far the world has known; which has organised the stupendous ceremonial witnessed on Tuesday in the metropolis, a celebration to be worthily crowned on Saturday by the review of the first line of the armed force of the nation.

These most memorable events in the annals of our time—events, indeed, beyond all precedents of former times—which have so emphatically marked Her Majesty's Diamond Jubilee, have naturally been connected in many minds with the progress of the nation during the last sixty years. It is satisfactory to note the general recognition in the daily and weekly press of the importance of the part played by science during that interval in securing the tremendous advance which has been achieved, along many lines, in things pertaining to the increased well-being and usefulness of mankind.

It is very generally recognised that the Victorian age is emphatically the age of science, and indeed so true is this that a hasty sketch of the progress of natural knowledge during the last sixty years would require a volume. So great has been the advance, so rapidly are all benefits conferred by science applied to our daily needs, that it is extremely difficult already to obtain a mental image of many conditionings of life sixty years ago, and it is not a little singular that many of the advances made, which in some cases have profoundly influenced modern thought, and in others have enormously increased the happiness, comfort and usefulness of our lives, are very nearly conterminous with the reign.

How changed are the Imperial conditions even from the year of the famous Great Exhibition, when, in the language of Tennyson, there were poured upon our shores,

> ——"Things of beauty, things of use
> Which one fair planet can produce,
> *Brought from under every star.*"

In the year 1837 the possibility of telegraphy was first realised, and Faraday was at work at frictional electricity. Who can attempt to measure the value of this early electrical and magnetic work, either from the pure science or applied science point of view? Has not the close binding together of the various units of the Anglo-Saxon race which has brought citizens of the Empire from under every star been among the indirect results?

From that year to the present time not a sea, but an ocean of marvels has been discovered. Our view has been obscured by day with wires carrying currents, some of which illuminate our cities and houses at night, while others carry our messages to the ends of the earth. Surely in all this progress in one restricted branch since 1837 we have a clear indication that the study of the useless—useless because it has never been used—is the surest way to discoveries rich in public utility.

It has also been recently pointed out that the art and science of photography are conterminous with the reign.

> "In 1837 Daguerre and Fox Talbot were founding photography. The Daguerrotype and Talbotype were given to the world two years later. What would the modern world do without photography, as we know it in this year of Jubilee? It has added ten thousand million stars to the astronomer's stock-in-trade; it is an invaluable ally in the study of the physics and chemistry of distant worlds; while with a grand impartiality it reveals to us the secrets of the infinitely little. Last of all, not content with adding to the pleasures and the knowledge of mankind, it comes to succour human ills, and soon no hospital will be without its aid."

We may note with pride that in the Victorian era Britain has well retained her place, not to say her supremacy, in the realm of ideas. One of the great poets—the makers—of science whose name will go down to posterity with that of Newton has added lustre to the Queen's reign.

But we may warmly congratulate ourselves that something more than science itself has advanced; the importance of its methods and results in relation to the future progress of the nation is at last receiving a tardy recognition.

The progress of science itself and its results are naturally not confined to any one nation under the new world condition of almost instantaneous exchange of thought, but this same possibility of rapid exchange also applies to the transit of raw material. Britain in the past had for years a practical monopoly of coal and iron; this was her strength, but this strength is hers exclusively no longer.

At the present day Britain is distinctly behind Germany in the national endeavour to face the conditions of national peaceful competition as they exist. Our Government has been supine in matters in which the German Government have put forth all their strength, and so, even assuming that the scientific spirit and the individual endowment and advancement have been the same in both countries, we have fallen sadly into arrear as to those educational and scientific institutions on which we must depend for the future production of workers and new discoveries.

There are signs that this condition of things is mending, that the error is being acknowledged by those who, if they choose, can readily correct it. The Duke of Devonshire last week, at the opening of the International Congress on technical education, announced frankly: "We have in this country a Department of Education, but its functions are almost entirely limited to elementary education, and we have not in our Administration any minister who properly corresponds to the Minister of Education of other Governments."

It is as if one should say, "We have in this country a Department of War, but its functions are almost entirely limited to teaching the goose-step to recruits."

Another encouraging sign is to be found in the recent increase in the assistance rendered to the University Colleges, all of which outside the metropolis have been

founded during Her Majesty's reign. At the same time the establishment of similar institutions in other localities is encouraged by the promise of grants to them also under certain specified conditions. But in relation to our advance in this direction, it is a matter of regret to all friends of the higher education that the so-called University of London, which was established in the year before Her Majesty came to the throne, is not yet a University in the true sense. Is it too late to hope that the Jubilee year may yet be signalised by bringing London in this matter up to the level of the smaller cities of the world?

In still another direction an important advance must be noted. We refer to the inclusion of men of science among those upon whom the Sovereign confers distinction for services rendered to the State. More than forty years ago the Queen expressed her desire to include among her Privy Councillors two distinguished men of science, and yet, owing to one cause and another, the conferring of this distinction upon a man of science did not take place till a few years ago, when Huxley was enrolled among the members of that body. There are signs that the opinion is rapidly growing that if the function of a Privy Council is to give wise counsel in the nation's need, the increased utilisation of science in every part of the national machinery, whether it deal with the arts of peace or war, renders it not only desirable but necessary that the ranks of the Privy Council shall be strengthened in this direction. There can be little doubt that in a not distant future the Lords of the Committee of the Privy Council who deal with matters concerning science will contain among them many members of the Royal Society.

There is also another matter to be considered in relation to the Queen's reign. It is the steady increase in the usefulness, the utilisation, and the dignity of the Royal Society. This throws an ever-increasing responsibility upon its Officers, Council and Fellows, among other things in the selection of their successors.

Other vast fields of activity are gradually and necessarily being added to the original ones of discussion and publication, and wisdom as well as knowledge is now essential in the proper direction of its energies. The view, therefore, still held by some, that the Society is a kind of superior college of preceptors of a strictly limited number of branches of knowledge, is rapidly disappearing as Her Majesty's reign continues.

At the present time, on the one hand, the Government does not hesitate to consult the Society when need arises, and, on the other, it rarely refuses to accede to demands made upon it to assist research in various directions where the State influence or machinery, or both, can be utilised. The memorable voyage of the *Challenger* and various eclipse expeditions are excellent cases in point. The gigantic work recently undertaken by the Society in organising the production of an International Catalogue of Scientific Literature has only been rendered possible by the sympathy and assistance of the Government; and the more similar works of large grasp the Society is connected with in the future, the more respected British science will be all the world over, for the responsibility of the Royal Society is no longer confined to these islands.

DUCAL HUSBANDMEN.

A Great Agricultural Estate, being the Story of the Origin and Administration of Woburn and Thorney. By the Duke of Bedford. Pp. 254. (London: John Murray, 1897.)

First Report on the Working and Results of the Woburn Experimental Fruit Farm. By the Duke of Bedford and Spencer Pickering, F.R.S. Pp. iv + 194. (London: Eyre and Spottiswoode, 1897.)

ONE is tempted to believe that agriculture has been in the blood of the Russell family not only by inheritance, but by heredity. It has been to the Earls and Dukes of Bedford what politics has been to some families and drink to others—a deadly recurrent outbreak. It apparently began with a lady, the wife of the third Earl, who, according to Sir William Temple, contrived "the perfectest figure of a garden" at Moor Park. Her offspring in successive generations have been famous improvers of estates, plantations, fields and gardens. It was John, the fourth Duke, who in defiance of the remonstrance of the celebrated Philip Miller, his gardener, thinned his famous plantation of pines and firs, and so that there might result no injury to Miller's reputation as a planter, caused a board to be fixed in the plantation, facing the road, on which was inscribed, "This plantation has been thinned by John, Duke of Bedford, contrary to the advice and opinion of his gardener." The draining, planting and experimenting has gone forward almost continuously from the time when Francis, the fourth Earl, devoted attention, capital and reputation to draining the fen lands. The great drainage works of the Romans, maintained by the monks of Thorney, Crowland, Ely, &c., had fallen out of repair by the end of the sixteenth century, and "it was only on the maps that the rivers [of the fen country] ran into the sea" when he undertook the task afresh. The reward for this, as related by the present Duke, was that Charles I. sent Earl Francis to the Tower, and his son Earl William, who incurred the enmity of the Parliament during the Civil War, had his estates sequestrated for a time. But through bad times and good the Bedfords have been of like mind with Sir Walter's Laird of Dumbiedikes, who, on his death-bed, remarked, "Jock, when ye hae naething else to do, ye may be aye sticking in a tree; it will be growing, Jock, when ye're sleeping." The present Duke has, fortunately both for science and practice, not only maintained the famous Woburn experiments, but has broken out in a new place with the establishment of a splendid experimental fruit farm, designed quite as much for purely scientific as for economic ends. With the scientific advice of Mr. Pickering, who in this matter also appears to his fellow scientific workers in a new character, this great garden has been laid out and the work of record begun. Even in these first years results of interest appear, but they are small compared with what future generations will reap. It is difficult from this first Report to gather more than admiration of the plan; but those who have seen the fruit farm, cannot fail to have carried away the conviction that it is one of the most notable experiments in rural economy now in progress.

In addition to this solid service, his Grace has compiled a statistical account of the management of the estates of

Woburn and Thorney as material for a discussion of the land question. To review it adequately here is impossible, since it would lead one straightway into political discussion. The returns from the Beds, Bucks and Thorney estates, as set forth in the appendix, show the following financial results. "On Thorney the expenditure, from 1816 to 1895, amounted to 1,598,353*l*., and on Woburn, from 1816 to 1895, it was 2,632,186*l*. After spending nearly four and a quarter millons sterling since 1816 on some 51,643 acres of land, a large proportion of which is some of the best wheat land in England, and after excluding all expenditure on Woburn Abbey, its park and farm, it will be seen that at the present time an annual loss of more than 7000*l*. a year is entailed on their owner." Elsewhere we read: "As to the pleasures to be derived from the ownership of an estate like Thorney, if the reader conjures up a beautiful mansion and park with endless game preserves he is mistaken. They do not exist. The only pleasure which I and my forebears can have derived from Thorney is the kindly feeling which has existed," &c. It would be a fatal mistake to suppose that the Duke has compiled these tables of statistics, and written this most interesting book to demonstrate the philanthropic principles of his ancestors, or to justify his own position as a landlord—"such pride is hardly wrong," as Mr. Gilbert sings—but rather to enable him to have a fling at John Stuart Mill, and to justify all landlords. Without entering on politics, one may point to the weak spot in his argument. He innocently fancies all or most landlords to be as the Russells. If they were, the land agitator would carry on his operations with a plough.

GEORGE MURRAY.

AN ISLAND OF THE EASTERN ARCHIPELAGO.

With the Dutch in the East. By Captain W. Cool (Dutch Engineers). Translated by E. J. Taylor. Pp. viii + 365. (London: Luzac and Co., 1897.)

THE past few years have been marked in a peculiar degree by disturbances in the various colonial dependencies of European nations. Not only in Central Africa—where the recent forward movement for the opening up of the continent has naturally led to collisions with native races—but in many of the older colonies in other parts of the world, it has been necessary for the paramount power to maintain its supremacy by force of arms. The recently translated work of Captain W. Cool gives a detailed narrative of one such war, undertaken by the Dutch in 1894 to deliver the subject population of the island of Lombok from the oppression of their Balinese rulers. The author tells the story of the expedition in a somewhat dramatic style, giving it almost the complexion of a national epic. In fact, accustomed as we are in this country to such small colonial wars, we might be inclined to think that he has attempted to raise it to a level unwarranted by the facts of the case. But the expedition had an importance beyond what might appear at first sight. It may even be said to have formed in some way a turning-point in Dutch colonial history. The difficulties encountered during the Achin war, and the unfortunate experiences of the Flores expedition had seriously threatened the Dutch prestige in the archipelago, and failure or only partial success at Lombok might have been regarded as indicating that Holland was now unequal to the task of maintaining her hold on her extensive colonies in the East. In spite of some reverses, which necessitated the dispatch of considerable reinforcements, the general result of the war was fortunately most successful, and will, it may be hoped, have conferred a lasting benefit on the island in the form of good and settled government for the future.

English literature on the subject of the Eastern Archipelago is so scanty, and the works of Dutch writers—naturally by far the most numerous—are so little known in this country, that any addition to our knowledge of that part of the world is welcome. With regard to Lombok, we believe that almost the only information—obtained at first hand—to be found in English works, is that contributed by Dr. A. R. Wallace, who, in 1856, crossed from side to side of the island; and in his "Malay Archipelago" devotes two interesting chapters to the manners and customs of the people. Apart from the story of the military operations, Captain Cool gives, in his third and fourth chapters, a useful summary of all that is known of the island and its inhabitants, with a sketch (considerably shortened in the English translation) of the connection of the Dutch with it from the time of their first voyages to the Far East. Being confined to the neighbourhood of the west coast, the expedition did not, unfortunately, add much to our knowledge of Lombok, which, though small compared with other islands of the archipelago, is still little known apart from a narrow strip across the centre. Captain Cool's information is therefore necessarily compiled in great part from previously published works, those of Zollinger and Jacobs in particular being largely drawn upon. He gives a most unpleasant picture of the state of morals in the island, the Brahminical Balinese rulers being decidedly worse in this respect than the subject Mohammedan Sassaks. The oppression and tyranny of the former is likewise painted in strong colours, although Wallace thought the Sassaks in his time reconciled to their then new rulers. The island has undoubtedly everything to gain from being brought more closely under the influence of the Dutch authorities.

The author's style is one which hardly lends itself well to exact reproduction in English, and might perhaps with advantage have been somewhat modified by the translator. The short paragraphs, constant use of question and answer, and of the note of admiration, are apt to be worrying. The book contains a sketch-map of Lombok, and some good illustrations, both of scenery and people, and is provided with a full and well-arranged index.

OUR BOOK SHELF.

Die elektrodynamischen Grundgesetze und das eigentliche Elementargesetz. Von Franz Kerntler. 8vo. Pp. 68. (Budapest: Buchdruckerei der Pester Lloyd-Gesellschaft, 1897.)

THOSE who take up the present book with the expectation of finding in it a full and comprehensive sketch of the principles of electro-magnetism will be disappointed. Dr. Kerntler's work might, perhaps, be best described as an essay on "Ampère's Law and Allied Theories,"

since it deals exclusively with that debated point, the action of two elements of current on one another.

So long as Maxwell's theories of the mutual induction of closed circuits are taken as the starting-point, a certain indeterminativeness must inevitably arise in the endeavour to isolate the effects of separate portions of the circuits. It is with the various rival hypotheses required to complete the solution of the problem that the present investigation deals. In the first section we have an account of Ampère's hypothesis and the laws of force resulting from it. The next section deals with the most general law of force, based on the law of the inverse square; this is followed by a section devoted to Maxwell's investigations, and finally Dr. Kerntler propounds a new law of force which, he claims, is free from the objections raised by him against Ampère's, Neumann's, Weber's, and other formulæ. This law is merely obtained by assigning certain values to the arbitrary constants which occur in the expressions for the force-components, and which satisfy the relations found by Stefan. The subsequent applications of the proposed law to finite portions of conductors form an interesting collection of problems.

An important feature is that the author divides the various hypothetical laws into two categories—those which are applicable to determine the action between closed circuits only, and those which give correct results when used to find the action of a closed circuit on an element of current.

In former times, when the doctrine of action at a distance held the field, such an investigation as the present would, doubtless, have attracted many supporters, between whom and the advocates of Ampère's and other laws a spirited controversy might have arisen. At present we have become so accustomed to regarding the seat of electro-magnetic action as residing in the dielectric, that it is difficult to regard any investigation of direction action and reaction between two elements of current as being of more than purely academical interest. Still, the fact that many of our text-books base their introductory treatment, both of electrostatics and of magnetism, on the theory of action at a distance renders it desirable that interest should be resuscitated in these attempted solutions of the corresponding problem for electric currents; and for this, if for no other reason, the present endeavour to establish a new formula cannot fail to be worthy of the attention of physicists. G. H. B.

Catalogue of Tertiary Mollusca. Part i. The Australasian Tertiary Mollusca. By George F. Harris. Pp. xxvi + 407. Eight plates. (London: Printed by order of the Trustees of the British Museum, 1897.)

Catalogue of the Fossil Cephalopoda. Part iii. The Bactritidæ and part of the sub-order Ammonoidea. By Dr. Arthur H. Foord and George Charles Crick. Pp. xxxiii + 303. Illustrated. (London: Printed by order of the Trustees of the British Museum, 1897.)

THE present work by Mr. Harris commences a new catalogue. This first part is devoted to descriptions and figures of the shells of Australasia (exclusive of Cephalopoda), and will be followed, in due course, by other geographical series in the collection. The larger part of the Mollusca and Bryozoa, and the whole of the Brachiopoda, Annelida, Arthropoda, Echinoderma, and Cœlentera, still remain to be recorded, as well as the greater portion of the fossil plants. When complete the catalogue will include at least thirty volumes, and will then contain no more than a brief account of these extensive collections in the Natural History branch of the British Museum.

The classes of Australasian Tertiary Mollusca described by Mr. Harris in the volume under consideration include the Gasteropoda, the Scaphopoda, and the Lamellibranchiata, and the author rightly points out that their study cannot fail to shed much light on certain questions relating to phylogeny, and to assist the zoologist in tracing the origin of many of the principal groups of these divisions of the Mollusca.

The eight plates, drawn by Miss G. M. Woodward, which accompany the text, are of the usual high order of excellence one associates with the publications of the Trustees of the British Museum.

The volume dealing with the Cephalopoda is mainly the work of Mr. Crick, though Dr. Foord, notwithstanding his removal to Dublin, has rendered all the assistance possible, in order to carry the work through the press. As Dr. Woodward points out in his preface, this addition to the catalogue will prove of extreme importance to all those who desire to study the phylogeny of this group, for we are here presented with conclusive evidence that the Goniatites almost imperceptibly pass into the Ammonites. The figures, of which there are one hundred and forty-five, prepared, with few exceptions, by Miss Woodward, assist very much in making the text clear.

The Story of the Mine, as illustrated by the Great Comstock Lode of Nevada. By Charles Howard Shinn. Pp. x + 272. (London: Gay and Bird, 1897.)

WE learn from the editor's preface that this volume is one of a series intended to explain how the Western States of America were explored, how cities sprang up in desert wastes or among mountains difficult of access, and how gradually these States have become the home of a thriving population. The part played by the miner in the wonderfully rapid development of the Great West is dealt with by Mr. Shinn in a masterly manner.

Taking the Comstock Lode as a typical example, he draws a vivid picture of the early prospecting and subsequent working. The pathetic story of the first discoverers, the brothers Grosh, who both perished before they could reap the fruits of their skill and energy, is probably unknown to most English readers; soon they were followed by hardy but ignorant prospectors, who began by working the gold which they chanced to find in the earth thrown up by a gopher, and threw away as valueless the very rich silver ore which accompanied it. An assay of the "blue stuff," carried by a farmer to a distant town, revealed the true wealth of the marvellous vein; but difficulties of all kinds beset the miner in his endeavours to work it. How they were overcome by pluck, perseverance and science, is told in Mr. Shinn's pages; these should be read by every student of mining, for he may glean from them much valuable information, which is usually placed before him in a less tempting fashion in his dry technical manuals. Numerous illustrations add value to the text. The view of the Belcher Mine shows very clearly how the huge underground excavations are supported by "square sets," and might well be copied as a diagram for teaching purposes. The picture of hydraulic mining is excellent, and decidedly better than some similar illustrations which appear in text-books on mining. It is a pity there is no index.

C. L. N. F.

First Stage Sound, Light and Heat. By John Don, M.A., B.Sc. Pp. 307. (London: W. B. Clive, University Correspondence College Press.)

THE syllabus of the Science and Art Department's elementary examination in Sound, Light, and Heat, is the framework upon which this book has been constructed. The facts and phenomena belonging to the branches of physical science named in the title of the book are clearly described, and with due attention to experiment. Teachers of Departmental classes will be attracted to the book by its conciseness, by the summary at the end of each chapter, and by the large number of exercises and problems to be found in its pages.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Great Submergence.

THE glaciation of the hills and glens all over the west of Argyllshire present phenomena which have for many years convinced me that the chief glaciating agent cannot possibly have been what is called an "ice-sheet." Ordinary glaciers, descending from the hills, have probably been concerned more or less. But the main agency has been, in my opinion, heavy "floe," or floating ice, driven by tides and currents during a submergence and a re-emergence of the land to the extent of at least 1500 feet. The main objection to this view has always been the absence of marine deposits, and especially of marine organisms. It is true that we have very few remaining beds of gravel or sand, and in those, as yet, no mollusca have been discovered. But I have never thought this objection a very strong one, because the submergence may not have been under conditions favourable to molluscan life, and dead shells, carried where they never lived, may easily have long ago been dissolved out. Quite recently, however, shells in great variety have been found at high elevations in Ayrshire, by Mr. Smith, of Kilmarnock. Moreover, these are embedded in the true boulder clay. And where these are wanting, marine microzoa have been detected in abundance by the most skilled and distinguished microscopist of the day. Stimulated by these discoveries, I have lately made a closer search for any remains of loose sands or gravels among our hills. That search has been rewarded by finding a well-marked fragment of an elevated sea-beach at the height of 350 feet above the sea, and in this deposit foraminifera have been found in fair abundance. Another place, quite 500 feet above the sea, has yielded similar evidence; and I have now very little doubt that such evidence will accumulate as the result of further search. This, however, is enough to prove a very recent submergence to a depth which would profoundly alter the distribution of sea and land along all our shores, and would divide the county of Argyll into a group of islands. No reasonable limit can be placed to the possible depth of this submergence. I have no theory as to the causes of it. But it may quite as well have been 1500 as 500 feet; and we must yield to any clear evidence of effects which cannot otherwise be explained. I need not say that the evidence, which in the latest years of his life carried conviction to the mind of the late Sir Joseph Prestwich, that there has been very lately in geological history a great submergence, which was comparatively sudden and comparatively transient, is evidence which no geologist can put aside without the fullest and most candid investigation.

ARGYLL.

The Visibility of a Sound Shadow.

TWO months ago I received the following letter from Mr. E. J. Ryves.

"On Tuesday, April 6, I had occasion, while carrying out some experiments with explosives, to detonate 100 lbs. of a nitro-compound. The explosive was placed on the ground in the centre of a slight depression, and, in order to view the effect, I stationed myself at a distance of about 300 yards on the side of a neighbouring hill. The detonation was complete, and a hole was made in the ground 5 feet deep and 7 feet in diameter. A most interesting observation was made during the experiment.

"The sun was shining brightly, and at the moment of detonation the shadow of the sound wave was most distinctly seen leaving the area of disturbance. I heard the explosion as the shadow passed me, and I could follow it distinctly in its course down the valley for at least half a mile: it was so plainly visible, that I believe it would have photographed well with a suitable shutter."

On receiving this note, I asked and obtained permission from Mr. Maxim to be present if a further experiment of the kind were contemplated. I designed and had prepared a special shutter which, on the breakage of an electrical circuit, would in the 40th second make an exposure of about 1/300 second. Unfortunately the battery that I brought with me proved insufficient, so that I had to discard this, and use an ordinary Thornton-Pickard shutter actuated by hand. Neither the exact moment nor duration of the exposure were under such perfect control, and, as events proved, I could not get the exposure until the shadow had passed me. I had, however, fortunately asked Mr. Paul if he would be so good as to take a picture of the explosion with his animatograph. Mr. Hunt, his manager, came himself, and secured a good series.

Returning now to the eye observation: Mr. Ryves informed me he saw the expanding shadow on an intermediate occasion when only about 10 lbs. were detonated. On the day on which I was present (May 19), about 120 lbs. of nitro-compound were detonated, and 10 lbs. of black powder was added to make sufficient smoke to show on the plate. As the growth of the smoke cloud is far less rapid than the expansion of the sound shadow, no confusion could result from this.

At the time of the explosion my whole attention was concentrated upon the camera, and for the moment I had forgotten to look for the "Ryves ring," as I think it might be called; but it was so conspicuous that it forced itself upon my attention. I felt rather than heard the explosion at the moment that it passed. We stationed ourselves as near as prudence would allow at a distance of 120 yards, so that only about one-third of a second elapsed between the detonation and the passage of the shadow; but the precision of observation of coincidence when very rapid movement occurs is so great, that I am quite satisfied that the observation was correct. The actual appearance of the ring was that of a strong black circular line, opening out with terrific speed from the point of explosion as a centre. It is impossible to judge of the thickness of the black shadow; it may have been 3 feet, or it may have been more at first, and have gradually become less in thickness or, possibly, in depth of shade.

I have some difficulty in understanding why the whole ring should be visible if the phenomenon is the same as that which Prof. Mach and I have photographed. In our cases a bullet travelling at a speed greater than that of sound, forms a hyperboloidal shell of compressed air round about it. Light waves passing nearly tangentially, but just entering the shell, are refracted inwards, and thus leave a black line when they fail to strike the photographic plate. As they strike the plate within this black line on a part to which other rays have come nearly direct, an extra bright line is formed within the dark one. That which is essential, however, for the formation of the dark line is the tangency of the incident light.

Now, in the case of a hemispherical explosive wave it is clear that the sunlight can only be tangential over a semicircle, and that the shadow of such a wave should be a semi-ellipse, the eccentricity of which would depend upon the altitude of the sun. There could be no true tangential shadow on the sunward side of the explosion. Observation, however, showed a complete ring. If, as has been suggested to me as possible, the explosive wave does not travel at equal speeds in all directions, but is retarded near the ground, the wave front near the ground might be sufficiently inclined for the sun's rays to be tangential over much more than a semicircle. On May 19, when I made the observation, the sun had an altitude of about 58°, but on April 6, when Mr. Ryves made his first observation, the altitude was only 45°.

Mr. Maxim, with his usual ingenuity, suggested that perhaps what was observed was not a sound shadow at all, but merely a progressive wave bending down of every blade of grass as the explosive wave passed by. This would no doubt occur, and might be visible, but it is difficult to see how so black a ring should be produced in this way.

The animatograph fails to show any black ring; and this is not surprising, as with the exposure of about 1/100 second the shadow would have to be at least 11 feet thick, in order that some part should remain obscured during the whole exposure. If the black line is just without an equal bright line, as in the bullet photographs, and both are taken in by an exposure, it is hardly to be expected that any definite result should be obtained. As a fact, there is clearly seen a circular light shading, which does—so far as one can judge from the supposed rate of working, and the known distances—expand at about the same rate as the observed shadow, but it is lighter than the ground and shaded, instead of being dark and sharp, as seen by the eye.

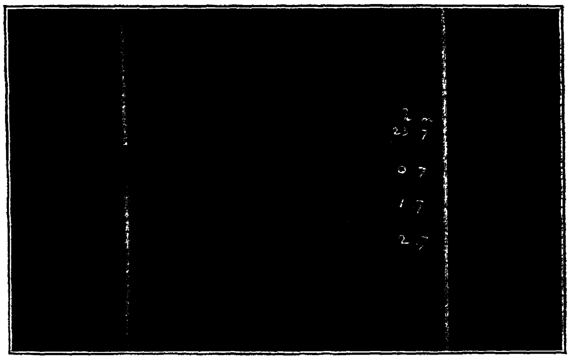
I feel that the imperfect account which I am able to give is of sufficient interest to appear in the columns of NATURE, but I hope that it may induce those who have occasion to detonate heavy charges to make any observations that opportunity allows.

For instance, if the Ryves ring is only visible in direct and brilliant sunshine, that will be evidence in favour of the shadow theory. If it is equally visible when the sun is not actually shining, but when the sky is illuminated by numerous white clouds, that will be evidence of the grass theory.

I may add that our observations were made from the west, and at noon. C. V. BOYS.

An Edinburgh Record of the Indian Earthquake.

A VERY interesting record of the recent earthquake at Calcutta is shown by the photographic apparatus of the bifilar pendulum of this observatory. A few very slight preliminary tremors commenced June 11, at 23h. 18m. G.M.T., and lasted for ten minutes. Violent oscillations then commenced suddenly, and lasted to June 12, 0h. 33m., after which slighter tremors



continued up to 1h. 12m. The oscillations can be traced fully six times the measure of sensitiveness of the instrument on one side of the normal line, and four times on the other, which are together equivalent to a tilt of the supporting frame of about twenty seconds of arc. I enclose a negative of the original photograph, which, however, does not show all the minor details of the effect produced. THOMAS HEATH.

Royal Observatory, Edinburgh, June 15.

Subjective Transformations of Colour.

MR. SHELFORD BIDWELL'S experiments, described in NATURE of June 10 (p. 128), remind me of a phenomenon which can be very easily demonstrated.

A disc is arranged so that a small sector, about one-sixth, is of a bright colour, while the remaining portion is white. If this be rotated slowly, the coloured sector appears to be followed by a ghost of the complementary colour: on quickening the rotation, *the original colour is lost, and the whole disc appears to be of the complementary colour*: but if the rotation be further quickened until flickering ceases, the original colour again predominates. In this way emerald-green may appear to change to pink, or crimson-lake to green.

This seems to be another instance in which the negative after-sensation is stronger than the original sensation. For the success of the experiment it is probably necessary so to adjust the rotation that (*a*) the negative sensation has a longer duration than the original sensation, and (*b*) the next original stimulus shall follow before the after-sensation has entirely faded. If the rotation be too rapid, the negative sensation has not time to develop, and only the original colour is seen.

Mason College, June 12. F. J. ALLEN.

Planetary Orbits, illustrated by a Rolling Ball.

THE interesting article in NATURE, April 29, by R. W. Wood, on the orbits of a steel ball about a magnet pole, suggests to me that it may interest some of your readers to hear of another plan for showing these orbits, which, but for the slight resistance of the air, is very nearly theoretically accurate, and in which the proper initial velocities are easily produced.

The plan consists of causing a true steel ball—of, say, one inch or more in diameter—to roll on a hard and smooth surface of the proper form. The surface on which the *centre* of the ball moves is formed by the revolution of a part of a rectangular hyperbola about a vertical asymptote, and the real surface on which the ball rolls is, of course, a distance equal to the radius of the ball from this imaginary surface at all points.

Fig. 1 is a vertical section, on a very small scale, in which the dotted lines show the rectangular hyperbola and its vertical and horizontal asymptotes, and the full curved lines show the actual surface on which the ball rolls; the interval between the dotted and full curved lines being equal to the radius of the ball.

FIG. 1.

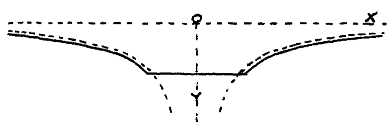


FIG. 2

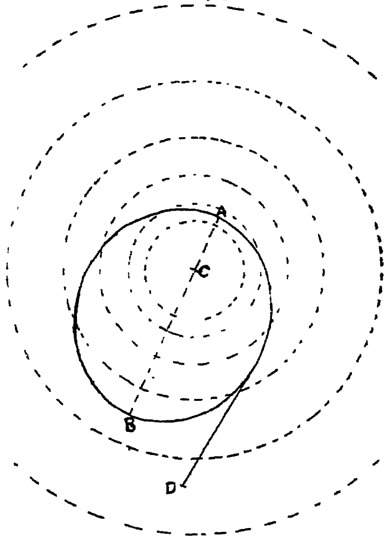


Fig. 2 is a projection on a horizontal plane showing contours of the hyperbolic surface at equal vertical intervals in dotted lines, and also one of the orbits referred to below in full lines.

Suppose the ball to be allowed to roll from the level of the horizontal asymptote, and directed so as not to come too near the centre (C) of the surface, it will describe a path whose projection on a horizontal plane is very nearly a parabola; and—as in the imaginary case of a comet coming from an infinite distance without initial velocity—its energy will be accurately in the inverse proportion to its horizontal distance from the centre of attraction, because the reciprocal of its distance from the centre is proportional to the vertical distance it has fallen, by the well-known property of the rectangular hyperbola. If the ball be allowed to roll from a point higher than the horizontal asymptote, it will describe a hyperbola; and if from a lower point, an ellipse.

To produce an ellipse having any given axis-major as A B, Fig. 2, let the ball roll from a point D, on the hyperbolic surface, whose distance from the centre C is equal to A B, and let it be directed with a straight-edge till it touches the desired orbit.

If we could neglect the resistance of the air and all other small resistances to the rolling of the ball, the actual energy, and therefore the velocity of the ball would be precisely what they ought to be to illustrate planetary motion; the direction of motion not being generally horizontal, however, and the orbit not exactly in one plane.

The fact that a part of a rolling ball's energy is rotational and part translational does not vitiate the experiment, because the proportion of the one part of the energy to the other remains constant.

In the case of a steel ball attracted by a magnet pole, the acceleration would appear to be inversely as some higher power of the distance than the square. In the case explained above, the acceleration is very nearly inversely as the square of the horizontal distance from the centre, and only differs from this proportion in being less, as the actual distance traversed by the ball exceeds its horizontal component, at any point; which may be a very small percentage. GEO. ROMANES.

Craigknowe, Slateford, Midlothian.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

II.

THE considerations which led me, in 1871, to employ a spectroscope without collimator may here again be summarised. If in an ordinary spectroscope, the straight slit be replaced by a circular one, bright rings replace the bright lines which are ordinarily seen in radiation spectra, and since in the solar surroundings we have chiefly to deal with radiation phenomena, the chromosphere and corona themselves can be used during an eclipse as ring slits, and on account of their distance, a collimating lens can be dispensed with.

In the report on the eclipse of 1875, by Dr. Schuster and myself, the principles of the method, as applying to photographs taken during totality, were stated as follows (*Phil. Trans.*, 1878, Part 1, p. 139):—

"Supposing that the corona and chromosphere only send out the same homogeneous light, one image only will appear on the sensitive plate, the only effect of the prism being to displace the image. As far as the protuberances are concerned we know they give a spectrum of bright lines, and we expect, therefore, to find on the plate each protuberance represented as many times as it contains lines in the photographic region. The different protuberances would be arranged in a circle round the sun, and these circles would overlap or not, according to the dispersive power of the prism and the difference in refrangibility of the lines. . . . If the corona gives a series of bright lines we shall find a series of outlines on the photographs similar to that corresponding to the protuberances. . . . If we find that part of the corona gives a continuous spectrum, that part alone will be drawn out into a band."

To this it may be added, that successive photographs will differ on account of the difference of phase. One part of the chromosphere will be visible at the beginning of totality, and another part at the end. The smaller prominences visible at the beginning of totality are subsequently eclipsed by the moon, and their spectra are consequently absent from later photographs, while a new prominence region makes its appearance. In the same way, the part of the corona the spectrum of which is photographed will vary at different phases, but only in the lower parts.

The results obtained by Prof. Respighi and myself during the eclipse of 1871 in India, in which part of the attack consisted in the employment of slitless spectroscopes—a method of work at which we had arrived independently—indicated the extreme value of such observations.

For my own observations in 1871 I had arranged a train of five prisms without either collimator or observing telescope. "I saw four rings with projections defining the prominences. In brightness, C came first, then F, then G, and last of all 1474K. Further, the rings were nearly all the same thickness, certainly not more than 2′ high, and they were all enveloped in a band of continuous spectrum" (NATURE, vol. v. p. 218, 1872).

Respighi's observations were made with a telescope of 4½ inches aperture, with a large prism of small angle in front of the object-glass. The principal results obtained by him were as follows (NATURE, vol. v. p. 237, 1872):—

"At the very instant of totality, the field of the telescope exhibited a most astonishing spectacle. The chromosphere at the edge, which was the last to be eclipsed, . . . was reproduced in the four spectral lines, C, D_3, F and G, with extraordinary intensity of light. . . .

"Meanwhile the coloured zones of the corona became continually more strongly marked, one in the red corresponding with the line C, another in the green, probably coinciding with the line 1474 of Kirchhoff's scale, and a third in the blue perhaps coinciding with F."

"The green zone surrounding the disc of the moon was the brightest, the most uniform and the best defined."

My observation (Brit. Assoc. Report, 1872, p. 331) was made intermediately between the two observations of Prof. Respighi. The observations may be thus compared:—

Respighi	C	D_3 ...	F.G.	Chromosphere and prominences at beginning of totality.
Lockyer	C	1474 (faint)	F.G.	Corona 80 secs. after beginning of totality.
Respighi	C	1474 (strong)	F.	Later.

I had no object-glass to collect light, but I had more prisms to disperse it, so that with me the rings were not so high as those observed by Respighi, because I had not so much light to work with; but such as they were, I saw them better, because the continuous spectrum was more dispersed, and the rings (the images of the corona) therefore did not overlap. Hence, doubtless Respighi missed the violet ring which I saw; but both that and 1474 were very dim, while C shone out with marvellous brilliancy, and D_3 was absent.

In arranging for the eclipse of 1875 in Siam and the Nicobars, the method was further developed by the introduction of photography, and the first results of this extension were given in the Report of the Eclipse Expedition of that year. They showed clearly that with the rapid dry plates of to-day a considerable increase of dispersion might be attempted.

The object-glass employed on this occasion had an aperture of 3¾ inches and a focal length of 5 feet, while the prism had a refracting angle of 8 degrees.

Two photographs were obtained with exposures of one and two minutes respectively. Both are reproduced in the Report (*Phil. Trans.*, 1878, vol. clxix. Part i. p. 139), and they show only such differences as can be attributed to difference of phase. The dispersion was very small compared with the size of the sun's image, so that the photographs present the appearance of an ordinary photograph of the eclipsed sun, which is slightly distended in the direction of dispersion. The various prominences each show three images, two of which were identified with $H\beta$, $H\gamma$, while the others were found to correspond to a wave-length of about 3957.

It was suggested (Report, p. 149) that this represented the H and K radiations of calcium, and this is fully confirmed by the results obtained in 1893, to say nothing of results obtained in other eclipses.

I next proceed to remark very briefly upon the photographic results obtained since 1875. In 1878, near the sun-spot minimum, the method was employed by several observers, myself among them, but no *bright* rings were recorded. The maximum sun-spot conditions previously observed had entirely changed; indeed with a slit spectroscope the 1474 line was very feeble, and was only seen by a few of the observers, and hydrogen lines were similarly feeble (*American Journal of Science*, vol xvi. p. 243).

Part of my own equipment for this eclipse consisted of a small grating placed in front of an ordinary portrait camera, and with this I obtained a photograph showing only a very distinct continuous spectrum.[1]

The method was employed by Dr. Schuster in Egypt in 1882; the camera was of 3 inches aperture and 20 inches focal length, with a prism having a refracting angle of 60° (*Phil. Trans.*, vol. clxxv., 1884, p. 262). The single photograph obtained (not reproduced in the Report) was stated to show two rings, which were considered to be due to the lower parts of the corona, and therefore to correspond to true coronal light. The wave-

1 Continued from page 157.

1 With a duplicate grating I observed the spectrum of the eclipsed sun, and again in three different orders, saw nothing but continuous spectrum (NATURE, vol. xviii., 1878, p. 459).

length of one of these rings was measured to be 5315; it is due to the green corona line (1474K). The second was stated to be coincident with D_3.

In 1883 the same instrument used in Egypt in 1882 was employed, as well as a 6-inch achromatic telescope, and a concave Rowland grating of 5 feet focus, arranged for taking ring spectra in the first and second orders.

It is stated in the Report (*Phil. Trans.*, 1889 A, vol. clxxx. p. 122) that the photographs "possess no features of interest," and neither reproductions, nor drawings nor measurements are given.

The prismatic camera employed in the eclipses of 1882 and 1883 was again used in the West Indies in 1886. Only the spectra of some prominences seem to have been recorded. There is no mention of rings. The hydrogen lines as well as K and *f* are noted (*Phil. Trans.*, 1889 A, vol. clxxx. p. 319).

While on the one hand the photographic results, to which reference has been made, certainly did not come up to the expectations raised by my observations of 1871; on the other, subsequent solar investigations confirmed my opinion that this was the best way of studying the lower parts of the sun's atmosphere, provided an instrument of much greater light-grasping power could be employed.

I determined, therefore, when arranging for the observations to be made during the eclipse of 1893, to renew the attack with the largest telescope and the greatest dispersion at my command.

The Solar Physics Committee was then in possession of a prismatic camera of 6 inches aperture. I decided, therefore, to employ it, all the more because the work on stellar spectra at Kensington had given abundant proof of its excellence.

The Eclipse of 1893.

The instrument was entrusted to Mr. Fowler, the demonstrator of astronomical physics in the Royal College of Science, who erected it at Fundium in West Africa, and obtained a series of photographs of the greatest value to science. A greater success has never been achieved in eclipse observations.

The object-glass of this instrument, corrected for the photographic rays, was constructed by the Brothers Henry. The correction is such that it is unnecessary to incline the back of the camera, and hence some of the objections which have been made to the use of this form of spectroscope are overcome. The large refracting angle of the prism (45°) obviously increases the value of the instrument for eclipse work.

The camera has a focal length of 7 feet 6 inches, and the spectrum obtained is about 2 inches long from F to K. Rings corresponding to the inner corona are about seven-eighths of an inch in diameter.

The tube is a strong mahogany one, square in section, and it was attached to the declination axis by means of a suitable iron plate. In order to reduce the weight of the instrumental equipment, the heavy iron pillar of the equatorial was replaced by a rough wooden stand which was filled up with concrete after being placed in position. Provision was made for the clock bracket and fine adjustments of the polar axis, and the whole arrangement was quite satisfactory.

Fig. 7 represents the instrument as adjusted for use in latitude 14° 3' N. When actually at work, the camera was steadied by a stiff wooden rod screwed to the end of the tube, and bearing on the end of the declination axis; this did not interfere with the driving gear and materially contributed to the successful results, as on account of the great weight of the prism it was necessary to bring a large part of the tube forward to the eye end. The brass cap which protected the camera from light other than that which passed through the prism and object-glass, is not shown in the diagram.

As time is very precious during an eclipse, every effort must be made to economise it. I may therefore refer to the manner in which the photographic operations were facilitated by the dark slides used.

The construction of the camera and dark slides, or plate-holders, was based on the plan which I devised for the large pictures of the corona which I hoped to obtain in the West Indies in 1886. The slides are about 13 inches in length by 7 inches broad, and have three compartments, each taking a plate 6 inches by 4 inches.

The camera at the end of the long wooden tube has an opening 6 inches square, and a rectangular frame 24 inches long, with a central aperture 6 inches by 4 inches, and provided with grooves to take the slides, was symmetrically attached to it. A dark slide being placed in the frame, so that the first compartment was opposite the middle of the telescope tube, the shutter was then opened to its full extent, and an exposure made; the plate in the second compartment was next brought to the middle of the frame, by pushing the slide along, and also exposed; again, by moving the slide along, the third plate was brought into position and exposed, after which the shutter was closed and the slide withdrawn. During the exposure of any one of the three plates in a slide, the other two were protected from light by the rectangular frame.

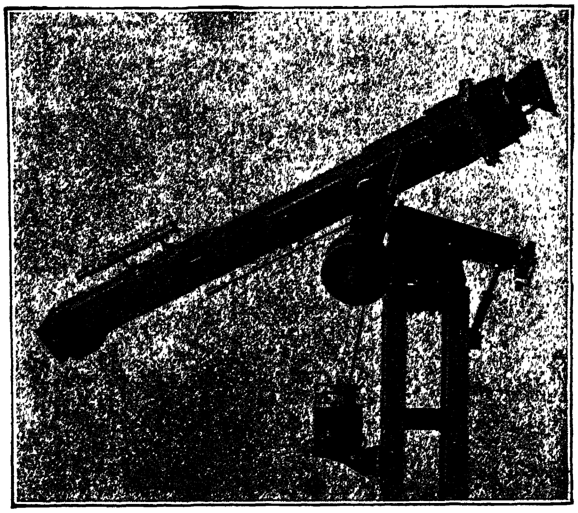


FIG. 7.—The 6-inch prismatic camera arranged for work during the Eclipse of 1893.

The upper edge of each dark slide was notched in three places corresponding to the positions of the three plates which it contained, and, as each plate came to the proper position for exposure, as the slide was pushed along, a spring catch automatically dropped into its place.

Upon the back of each dark slide six numbers were painted in clear white figures. A small series of numbers corresponded to the numbering of the thirty plates to be exposed during the eclipse, and a larger series indicated the exposures to be given to each plate, so that it was unnecessary to refer to any list.

These time-saving devices are of the highest importance in eclipse work, and too much attention cannot be given to them. The arrangements in West Africa worked admirably, and it was possible to change from one plate to another in about a second when a slide was once inserted, and to change the whole slide in five seconds. Longer intervals, however, were allowed to elapse between the exposures, in order that the instrument might steady itself, and to correct the backlash of the driving screw.

The instrument was focussed by photographing the spectra of some of the brighter stars. This is the only satisfactory method of focussing the prismatic camera, as rays from a star fall on the prism under exactly the same conditions as those from the eclipsed sun. If a slit and collimator be employed, identical conditions can only be obtained when the collimator is perfectly achromatic and absolutely adjusted for parallel rays.

FIG. 8.—Untouched reproduction of photograph (African station) taken very shortly after the commencement of totality, the exposure being "instantaneous." At this phase of the eclipse a considerable arc of the chromosphere was visible, and its spectrum is therefore shown in addition to the spectrum of the higher reaches of some of the large prominences extending beyond the moon's limb. It will be seen that at H and K there are long arcs of chromosphere and prominences, the absent portions being of course obscured by the moon. One very small prominence is especially rich in lines.

I next come to the kind of result obtained by means of the unprecedented optical power employed in 1893, and for this purpose I reproduce two of the beautiful photographs obtained by Mr. Fowler.

It will be seen that we get more or less complete rings when we are dealing with an extended arc of the chromosphere, or lines of dots when any small part of it is being subjected to a disturbance which increases the temperature, and possibly the number of the different vapours present.

The interpretation of these photographs brings us in presence of many interesting and, at the same time, complicated problems. I cannot, however, refer to them

FIG. 9.—Photograph 21 (African station), taken shortly before the end of totality. A portion of the chromosphere on the other edge of the dark moon is now visible in addition to numerous prominences. It will be seen that one of the smallest prominences is rich in lines, and closely resembles that which appears in Fig. 8.

here. I have set them out at length in the *Phil. Trans.* (vol. for 1896 A, p. 551).

The instrument so successfully employed by Mr. Fowler was not the only one used in 1893. I had been able to equip Mr. Shackleton, one of the computers attached to the Solar Physics Observatory,

with a large photographic spectroscope, deprived of its collimator, for use in Brazil. In this instrument we had two prisms of 60°. The object-glass was a Dallmeyer portrait lens 5D, aperture 3·25 inches, with a focal length of 19 inches. With this he was able to secure a second series of photographs.

The most important results recorded in 1893 may be stated as follows. We not only determined the wave-lengths with considerable accuracy of some 400 lines in the spectra of the chromosphere and prominences, and studied the distribution of the gases and vapour which gave rise to them, but the separation of the spectrum of the corona from that of the chromosphere was made perfectly clear. J. NORMAN LOCKYER.

(*To be continued.*)

WORK AND PROGRESS OF THE GEOLOGICAL SURVEY.[1]

THE first remark that will naturally occur to a geologist into whose hands this Report may come, will probably be one of satisfaction that the account of the work of the Geological Survey for the past year should have been brought out so early, and in a separate form in which the public can purchase it at a low price. But his pleasant surprise will soon be changed into feelings of another kind when he opens the volume and finds it printed, as heretofore, on poor, flimsy paper and in small, close type, so that the perusal of its pages becomes wearisome to the eyes. There could hardly be a stronger contrast to this style of production than that in which the Reports of the United States Geological Survey are issued. These, alike in paper, type and printing, are truly sumptuous publications placed alongside of the miserable efforts of our Stationery Office. Even Canada can afford to present the Reports of its Geological Survey in a form that should make our authorities blush. It is lamentable to see so much excellent scientific work offered to the world in such miserable guise. The Canadian Reports are not only better printed on better paper than ours, but they are actually sold at cheaper rates. Why cannot the mother-country afford to keep up to the level of her transatlantic colony?

The present Annual Report of the Director-General is the longest and most detailed which he has yet issued. It presents a clear picture of the activity of the Geological Survey over all the fields on which the staff is engaged, and enables the public to follow intelligently the progress of the work in the three kingdoms. The volume, or pamphlet of rather more than 100 pages, is divided into three sections, one dealing with the Geological Survey itself, one with the Palæontological Department, and one with the Museum of Practical Geology in Jermyn-street. The section that treats of the Survey consists of two portions, the first of which is devoted to the general statistics and administration of the three branches of the service in England, Scotland, and Ireland. It is interesting to notice in this, as in former Reports, the large extent to which the work of the Geological Survey is made use of for practical purposes. In different ways geology affords valuable information with regard to water-supply, reservoirs, drainage, soils, lines of railway, sites of houses, nature of building materials, and many other questions of daily life. The offices of the Geological Survey have become the recognised headquarters for information of this nature respecting the British Islands. The various Government Departments apply freely for assistance and advice, while the general public continues to make daily inquiries in regard to matters which involve a practical knowledge of geology.

[1] Annual Report of the Director-General of the Geological Survey of the United Kingdom for 1896. London: Printed for her Majesty's Stationery Office, 1897. Price 6*d*.

The scientific results obtained by the Survey during the past year occupy the greater part of the Report, and are full of interest. The narrative of them is arranged in stratigraphical order, beginning with the oldest rocks. We are first taken into the district of Charnwood Forest, and shown the excellent work done there recently by Mr. W. W. Watts. We are then transported into the north-west of Scotland, and watch the labours of Messrs. Peach, Horne, and Clough among the mountains of Assynt and the hills of Skye. The wonderfully complex structure of the country between Cape Wrath and the southern promontory of Skye has now been worked out in detail, most of the maps of that region are published, and we may before long expect a full account of the whole belt of complication from the able band of surveyors who, amidst all the inclemencies of that boisterous climate, and all the physical difficulties of rugged mountain and shaking bog, have so skilfully unravelled the details of one of the most interesting and difficult geological districts in Europe.

In the northern, central and southern Highlands satisfactory progress continues to be made. In the far north Mr. Horne and Mr. Gunn have been at work among the "Moine schists" of Sutherland and Ross-shire. Mr. Barrow and Mr. Cunningham Craig are to be found among the glens and corries of the higher Grampians. Mr. Hinxman is busy among the rocks of Strathspey. On the west side of the country a chain of observers is stationed from the flanks of Ben Nevis to Loch Awe and the hills of Lorne. Mr. Grant Wilson is engaged among the schists and limestones of Loch Linnhe. Mr. Hill has continued his investigation of the metamorphic series around Loch Awe. Mr. Symes has made progress with the volcanic district of western Argyllshire; while Mr. Kynaston has been laying bare the secrets of Ben Cruachan. The work of each of these investigators is succinctly summarised by the Director-General, and attention is called to the more important results obtained in the examination of the younger or Dalradian schists of the Highlands. The mapping is likewise in progress among the metamorphic rocks of the Western Isles, Mr. Wilkinson having now completed the survey of Islay; while Mr. Gunn is prosecuting that of Arran.

One of the most important problems now engaging the attention of the Survey in the Scottish Highlands is connected with the position and relations of a belt of comparatively unaltered strata, wedged in between the schistose rocks and the Old Red Sandstone which has been faulted down against them. These strata, from their lithological characters, their sequence, and their including certain radiolarian cherts, are regarded as probably the equivalents of the closely similar rocks which lie in the Arenig division of the Silurian rocks of the Southern Uplands of Scotland. If such should eventually be proved to be their true age, they will have an important bearing on the age of at least the latest movements to which the Highland rocks owe their contorted and puckered structure. The problem, however, seems to become more difficult the longer it is studied. Last year Mr. Clough, who is engaged on its investigation, has found that no satisfactory line can be drawn between the presumably Lower Silurian strata and the general mass of the rocks of the southern Highlands. If any portion of these rocks should prove to be of Palæozoic age, it would be a notable discovery in British geology. In the meantime we must patiently await the result of the continuation of further research along the Highland border.

The mapping of the Cambrian rocks of the north-west of Scotland has now been completed by the surveys in Skye made last year by Mr. Clough. One of the most singular features of these ancient deposits is the persistence of the same lithological bands for a distance of

100 miles from the mouth of Loch Eriboll into Sleat in Skye. Not only the bands of the Durness limestone, but the "fucoid beds" and the marked subdivisions of the underlying quartzite retain their general characters throughout the whole extent of their outcrop.

The mapping of the Isle of Man has now been completed by Mr. Lamplugh. Much information has been obtained as to the structure of the "Skiddaw Slates" of that island, but no further evidence has been found to fix their true geological age.

The revision of the Silurian formations of the Southern Uplands of Scotland has been brought to a close by Messrs. Peach and Horne, with the assistance of Mr. A. Macconochie. The whole complicated structure of that extensive region has now been unravelled. Among the more interesting recent additions made by these observers to our knowledge of the ground, has been the wide development of volcanic rocks associated with the Lower Silurian sediments. The chief interval of volcanic activity seems to have been the Arenig period; but last year evidence was met with of contemporaneous lavas in the Bala series of Peebleshire. In the Report some valuable details are supplied by Mr. Teall regarding the volcanic series of the Southern Uplands, and also the Galloway granites with their apophyses and attendant metamorphism.

The Silurian areas of Ireland are likewise undergoing revision, with the view of bringing the maps up to the present state of knowledge on the subject. The whole of the country north of Dublin has now been completed by Messrs. Egan and McHenry; while the fossil collector, Mr. Clark, has discovered many new localities for fossils in the Silurian rocks. The revision proceeds upon a careful search for organic remains, and the subdivisions of the Silurian formations are based essentially on the evidence of these remains.

Some important modifications of previously published views were obtained last year by Sir Archibald Geikie and Mr. Kilroe in the west of South Mayo and North Galway. Evidence was gathered which showed that the volcanic rocks of that region, hitherto regarded as of Upper Silurian age, undoubtedly belong to the lower division of the system.

In the Old Red Sandstone, the chief work accomplished by the Survey in 1896 lay in Ross-shire, Arran, and Argyllshire. In the first-named country two hitherto unknown outliers of this formation, capping hills of schist, were found by Mr. Gunn—striking monuments of the denudation of that region. In Lorne considerable progress has been made in the mapping of the interesting volcanic series of the Old Red Sandstone, and some suggestive observations have been made by Mr. Kynaston as to the possible connection of the andesite lavas with the granite of Ben Cruachan.

Among the Carboniferous rocks, the chief task on which the Survey is at present engaged is the revision of the coal-fields on the scale of six inches to a mile. Good progress is reported in the mapping of the great coal-field of South Wales, and a beginning has now been made with the publication of the re-survey. The new maps cannot fail to be of great value in the future development of the mineral resources of this important region. In general, each coal-owner knows only his own ground, and that often very imperfectly. No general acquaintance with the structure and resources of the whole coal-field can be obtained until all the scattered observations at the different mines are correlated and generalised. This, however, is a result which could hardly be effected by private enterprise. It is essentially a national undertaking, and it is this task on which the Geological Survey is now engaged. Mr. Strahan and his colleagues, who are charged with the re-survey, are to be congratulated on the excellent maps which they are producing. Not only are the Coal-measures receiving attention, but the surrounding older formations, the mapping of which is required for the completion of the sheets of the coal-field, are undergoing careful examination, and have already yielded some interesting new results. Thus Mr. Strahan last year discovered that the igneous rocks, which have long been supposed to be intrusive in the Carboniferous Limestone of West Somerset, really include intercalated tuffs, marking the sites of volcanic eruptions during Carboniferous time in the south-west of England.

Strata of Permian age are reported from the northern end of the Isle of Man, where they have been detected in some unsuccessful borings for coal. The younger red sandstones of the Isle of Arran are regarded as not improbably belonging to the same geological system.

Triassic and Rhætic rocks have been mapped over considerable tracts along the southern side of the South Welsh coal-field, and some interesting data have been obtained by Mr. Cantrill regarding the nature and origin of the breccias lying at the local base of these formations.

The most important area of Jurassic rocks examined last year lies in the district of Strath, in Skye, where the ground was mapped by Mr. H. B. Woodward, who has traced the lithological and palæontological subdivisions of the Lower and Middle Lias.

The Cretaceous system over considerable tracts of the south of England was examined during the past year for the purpose of mapping its subdivisions, the clear delineation of which is now found to have so important a bearing in questions of water-supply. Mr. Jukes Browne is engaged on the preparation of a general memoir on the Upper Cretaceous formations, and has had much assistance from Mr. William Hill, whose extensive and accurate knowledge of the subject has been placed at the service of the Survey.

The field-work in the south of England during 1896 lay, for the most part, outside of the areas of the Tertiary formations. Most of the mapping among rocks of that series was carried on in the west of Scotland, where so large and varied a development of Tertiary igneous masses occurs. Mr. Harker continued his investigation of the eruptive rocks of Skye, and contributes some important facts to the Annual Report. Mr. Hinxman noted two remarkable vents in Raasay, while Mr. Gunn was successful in adding a number of previous unknown particulars to our knowledge of the younger igneous rocks of Arran.

The Superficial Deposits, formerly entirely neglected, now receive a large share of the attention of the Geological Survey. As they thickly cover wide tracts of country, they are of paramount importance in regard to agriculture, water-supply, drainage and many other questions of daily life. It is most desirable, therefore, that their nature and limits should be accurately delineated upon maps. This has been done by the Survey over the whole of the northern half of England, and the same investigation is now in progress in the southern half. When the "Drift Survey," as it is called, is completed, the British Isles will be in possession of a map which will serve as an admirable guide to the farmer, well-sinker, engineer, and generally to the whole of that wide public that is practically interested in the relation of the soils and subsoils to all kinds of sanitary questions.

The Survey, while dealing with these applications of its work, does not lose sight of the intensely interesting geological problems presented by the various superficial formations. The present Report, like its predecessors, contains much fresh information on this subject. From the cwms of South Wales to the downs of Kent, the surveyors have been at work among the various drifts, and the more important of their observations are summarised by the Director-General. Of special interest are Mr. Lamplugh's generalisations regarding the successive stages in the history of the glaciation of the Isle

of Man, and Mr. Bennie's discovery of two ancient lake-bottoms near Edinburgh containing an arctic fauna and flora.

The Second Part of the Annual Report is devoted to the work of the Palæontological Department of the service, and contains a summary of the chief changes, additions and rearrangements made during the year in the palæontological galleries under the charge of Messrs. Sharman and Newton.

The general collections in the Museum form the subject of Part iii., wherein Mr. Rudler reports the principal events in the history of the Museum during 1896. It is satisfactory to observe that the collections continue to attract thousands of visitors, and that not only the general public, but schools, natural history societies, students' clubs, and individual students avail themselves of the admirable educational facilities afforded by the collections.

From what has here been said, it will be seen that the Annual Report of the Director-General of the Geological Survey is not a mere piece of dull statistics, but is an interesting and important contribution to science. It is a volume which will obviously be required in the library of every geologist, for it is crowded with observations which he will find nowhere else. Its publication as a separate work now places it within easy reach, and we trust that its sale will encourage Sir Archibald Geikie to continue the issue of as full a record in future years with perhaps, if the Stationery Office can be propitiated, diagrams illustrative of the more important facts described. In the meantime he and his able staff are to be congratulated on the appearance of so excellent a narrative of strenuous and successful labour.

STYLES OF THE CALENDAR.

AT the approach of the end of a century, this subject naturally comes to the front again; but it has lately been somewhat unexpectedly raised to special prominence by the suggested probability of one at least of the Oriental countries of Europe adopting the usage which, on the initiative of Rome in 1582, all the western nations gradually accepted, England (we say advisedly England *not* Britain, because Scotland adopted it before the union even of the crowns) being the last in 1752. America having been colonised by the western Europeans, and the United States having been still British colonies at the date last mentioned, the Gregorian style is universal in that continent. But eastern Europe, including Russia and all the nationalities of the Balkan peninsula, still adheres to the old Julian style; and this chiefly because the Christians of these countries belong to the Greek or Eastern Church, though it is difficult to see why this should restrain them from falling in with a change which has many conveniences, and would bring their dates into uniformity with those of the Latin, Teutonic, and Scandinavian nations—an object of increasing importance, as intercommunication is constantly becoming more frequent.

It is understood that for some time past, as the nineteenth century is drawing to its close, the question of a change has been discussed amongst the officials and astronomers of Russia; and that a plan was proposed to introduce it not by one operation, but gradually. Probably few persons amongst the general public reflect how essentially twofold the Gregorian alteration was; the object of making our calendar years correspond more accurately during the centuries with the tropical years of astronomers, so that the dates used should for all future time correspond with the equinoxes and other solar seasons, by no means implies the necessity of cancelling a number of days from the calendar so that these should correspond with what they were at some definite epoch in the past. The reason for this latter was purely ecclesiastical, the purpose being that, in celebrating Easter, the full moon following the vernal equinox should be governed by one bearing the same date as it did at the time of the Council of Nicæa. This the Eastern Church appears to have thought of less consequence than did the Western; and, indeed, it cannot be proved that on this point the Council did more than decree, in opposition to the so-called Quartodecimans, that Easter Day should always be kept on a Sunday. However that be, when it was noticed that the vernal equinox (which in the time of Julius Cæsar fell on the 25th of March, but in that of the Council A.D. 325, on the 21st), the question was from time to time agitated at Rome of effecting a change in the Julian reckoning. In passing it may be mentioned that Cæsar and Sosigenes the Alexandrian, who assisted him, were quite aware that the true length of the year was somewhat less than $365\frac{1}{4}$ days; the important point of the alteration of the calendar then carried out, was the abolition of the former cumbrous system of the Romans by combining a solar and lunar chronology with intercalary months, which were constantly falling into confusion, and the adoption of one wholly solar, the months being made artificial divisions, and it being thought that (the *exact* length of a year being not known) the regular introduction of an additional day every fourth year (making what we call a leap-year) would be quite sufficient for all practical purposes. Pope Sixtus IV. seriously took in hand the question of improving the Julian system, and in consequence of the great reputation of Regiomontanus (as he is commonly called from his birth-place, though his real name was Müller), who was making observations with his friend Walther at an observatory, the first ever made in Europe, erected by the latter at Nürnberg, sent for him to Rome to assist in this object, but, unfortunately, Müller died shortly after his arrival in 1476, which was about three years after the birth of Copernicus. The scheme was therefore again delayed, and was finally executed under the authority of Gregory XIII. in 1582. A century earlier it would have been adopted throughout western Christendom; as it was, the Protestant countries were slow to follow it, and some of the German States at first endeavoured to make some modifications by using a true instead of a calendar full moon, which did not work well in practice, because the moon is not necessarily full on the same day in different localities. England adopted the Gregorian style in its entirety (already, as we have said, used in Scotland), chiefly at the instance of Lord Chesterfield in 1752; and long before the end of last century the same rule was observed over western Europe, no further alteration having been made since, though it has often been noticed that even the Gregorian year is not absolutely accurate.

A definite proposal is now being made in one of the smaller eastern States for the abandonment of the Julian reckoning still observed by them, and the adoption of the Gregorian style. In the *Times* of the 11th inst., Signor Cesare Tondini de Quarenghi informs English readers that he has drawn up a Bill at the request of the Bulgarian Prime Minister, M. Stoiloff, to be shortly laid before the Sobranye for the purpose of effecting this change in Bulgaria; and he also states that he has been informed that Russia is desirous that this example should be thus set before being carried out in that country. How that may be, we are not in a position to know, but it is surely desirable (though even astronomers are not unanimous on the point) that the year should correspond on the whole, and as far as practicable, with its true length, whilst uniformity of usage throughout Christendom, would undoubtedly be a gain of convenience. We would fain hope that some international agreement might be come to by which, after the dropping of a leap-year in 1900, its regular omission at the end of each period of 128 years should be arranged. This would be a more

accurate rule than the Gregorian; and as by either 2000 would be a leap-year, the difference would first show itself in 2028, which, according to this arrangement, would not be a leap-year, whilst by the Gregorian scheme the next omitted leap-year would be 2100. The omission of a leap-year at the end of each period of 128 years was advocated, it may be mentioned, by Sir E. Beckett Denison (now Lord Grimthorpe) in his "Astronomy without Mathematics," and by the present writer in the "Companion to the British Almanac for 1882." Its accuracy may easily be shown. It signifies having 31 instead of 32 leap-years of 366 days in 128 years, and therefore 97 common years of 365 days. Now $365 \times 97 + 366 \times 31 = 46{,}751$, which, divided by 128, gives 365·2422, the actual length of a tropical year to the fourth decimal. We cannot close without expressing a further wish that some agreement may hereafter be come to amongst Christian nations to celebrate Easter also according to an exclusively solar chronology, by observing it on the first or second Sunday in April. That, however, is independent of the plan now proposed in Bulgaria to abandon the Julian style of the calendar.

W. T. LYNN.

GRANTS TO UNIVERSITY COLLEGES.

IN accordance with an undertaking given by the Chancellor of the Exchequer to a deputation which waited upon him at the end of 1895, with reference to increased aid from public funds for the University colleges, three gentlemen, viz. Mr. T. H. Warren (President of Magdalen College, Oxford), Prof. D. G. Liveing, F.R.S., and Mr. Robert Chalmers, of the Treasury, were appointed in March 1896 to visit the colleges sharing in the grant made to universities and colleges in Great Britain, and to investigate the character and quality of university work done, as well as to inquire generally into the position which each college occupied both financially and in other respects The visits were concluded by the end of last year, and the report came before the Lords of the Treasury about two months ago. The results of the inquiry showed the Chancellor of the Exchequer that a case had been made out for asking Parliament to increase the sum to the colleges sharing in the grant; he therefore recommended that the total grant to the colleges should be increased from 15,000*l*. to 25,000*l*. as from April 1, 1897. The question of the apportionment of this total sum was thereupon referred to a special Committee, whose recommendations, as will be seen from the subjoined Treasury Minute, have been accepted:—

My Lords read the report of the 20th ult. from the Committee appointed by the Treasury Minute of April 5 last to advise this Board in the matter of the apportionment of the increased sum of 25,000*l*. which Parliament has been asked to vote in the current financial year for University colleges in Great Britain.

My Lords accept the apportionment which the Committee propose, viz.:—

The Owens College, Manchester	£3500
University College, London	3000
University College, Liverpool	3000
Mason College, Birmingham	2700
King's College, London	2200
Yorkshire College, Leeds	2200
Durham College of Science	2200
University College, Nottingham	1500
Firth College, Sheffield	1300
University College, Bristol	1200
Bedford College, London	1200
	£24,000
University College, Dundee	1000
Total	£25,000

In deference to the express recommendation of the Committee, my Lords have consented to grant to the Owens College, Manchester, a sum in excess of the *maximum* of 3000*l*. specified in the Board's Minute of April 5, 1897. They desire, however, to make it clear that this increase is made solely in recognition of the pre-eminence of the Owens College, and must not be construed as a precedent for increasing the grant of any other college beyond the normal *maximum*.

My Lords take note of the term of the Committee's report with regard to the Dundee College. In acceding to the Committee's recommendation that "for the present" the college should receive 1000*l*. a year, my Lords are guided, as they understand the Committee to have been guided, by the exceptional position in which the college is now placed with regard to St. Andrews University. My Lords, however, are of opinion that, when the relations between the University and the college are settled, this matter should be subject to reconsideration; and they must not be understood to admit the claim of the college to share permanently in the grant to University colleges.

The Board accept, so far as they are concerned, the recommendation that, with the exception of Dundee College, the above allocation should be settled for a term of five years from April 1, 1897. They also agree that before the end of such term a further inspection should be made on behalf of the Treasury.

My Lords will communicate to the colleges concerned the Committee's recommendation in paragraph 6 of their report that, in certain cases, three-fourths of the additions to the several grants should be devoted to staff purposes.

The future inspection, as recommended by the Committee, should extend to the University Extension colleges at Reading and Exeter, as also to the Hartley Institute at Southampton, and to any other college which, being located in a populous district, may claim to be treated as a fully-equipped college in arts and science.

The Chancellor of the Exchequer invites the Board to consider the qualifications, other than educational, which should be required from a college seeking to share in the grant in future. The Chancellor of the Exchequer submits to the Board that public money should not be contributed to a college which is still in the experimental stage or which has not yet succeeded, though fully equipped, in attracting a considerable number of students in arts and science. He therefore recommends that the financial conditions of participation should be—(1) A total local income for arts and science of at least 4000*l*. a year; and (2) a receipt from fees in the same subjects of at least 1500*l*. a year.

My Lords approve. It only remains for them to record their appreciation of the valuable services which the Committee has been so good as to render to this Board in considering the claims of the respective colleges.

HONOURS FOR MEN OF SCIENCE.

THE honours list issued on Tuesday in connection with the Diamond Jubilee contains the names of a number of men of science upon whom her Majesty has been pleased to confer distinctions.

Dealing first with Fellows of the Royal Society, Mr. Crookes and Dr. Gowers receive knighthoods. In the order of the Bath, Mr. Wolfe Barry, President of the Institution of Civil Engineers, Dr. Frankland, Foreign Secretary of the Royal Society, Dr. Huggins, Mr. Norman Lockyer, Director of the Solar Physics Observatory, Dr. Thorne Thorne, Principal Medical Officer to the Local Government Board, and (naval promotion) Admiral Wharton, Hydrographer of the Admiralty, are appointed K.C.B.

Mr. Christie, Astronomer Royal, and Mr. Niven, Director of Studies at the Royal Naval College, are appointed C.B.

In the Order of the Star of India, Sir Joseph Hooker and Lieut.-General Strachey are promoted to the grade of G.C.S.I.

In addition to the foregoing, Baronetcies are conferred upon Sir Wm. MacCormac, President of the Royal College of Surgeons; Mr. Wilks, President of the Royal College of Physicians; and Mr. Thomas Smith, Surgeon-Extraordinary to her Majesty. Mr. Durston, Engineer-in-Chief to the Navy, is made a K.C.B., and knighthoods are conferred upon Mr. A. R. Binnie, the Engineer to the London County Council, and Dr. Felix Semon.

NOTES.

THE preliminary programme of the International Congress of Mathematicians, to be held at Zürich on August 9-11, has just been issued. The first general meeting of the congress will be held at nine o'clock on the morning of Monday, August 9, in the Aula of the Zurich Polytechnicum. M. Poincaré will commence the proceedings with a paper on the relation between pure analysis and mathematical physics. The next item on the programme is a report of the committee on the object and organisation of the congress; and this will be followed by a paper, by Prof. Dr. A. Hurwitz, on a development of the general theory of analytical functions. The afternoon and evening of Monday will be given to a banquet, a river excursion, and a soirée. On Tuesday, August 10, the congress will meet at 8 a.m. in six different sections, dealing respectively with papers on algebra and theory of numbers, analysis and theory of functions, geometry, mechanics and mathematical physics, astronomy and geodesy, history and bibliography. On Wednesday, August 11, the second general meeting will be held. The organisation of mathematical congresses will then be discussed, and the date and place of the next meeting will be decided upon. On the same day an address will be given by Prof. F. Klein, on the question of higher mathematical instruction, and one by Prof. G. Peano, of Turin, on "Logica mathematica." It is requested that mathematicians who propose to take part in the congress will communicate with Prof. Dr. A. Hurwitz, Falkengasse 15, Zürich, before August 1. A ladies' committee has been formed to look after the comforts of lady visitors while the congress is in session.

PARTICULARS of the construction of the wonderful steam-turbine-driven boat—the *Turbinia*—designed and built by the Hon. C. A. Parsons, were given in NATURE three weeks ago (p. 116). We understand that the *Turbinia* steamed to Cowes last week, stopping at Harwich, without the smallest hitch. On this long run without stop, the complete absence of vibration was greatly appreciated by all on board; from Harwich to Cowes speeds of from sixteen to twenty-eight knots were maintained. The *Turbinia* will be at Cowes and in commission during the review week, for the inspection of visitors and the Press representatives. She is now capable of steaming between thirty-four and thirty-five knots.

THE elevating floor of the Yerkes Observatory at Chicago fell on May 29, just one week after the 40-inch lens had been placed in position. The drop was from its highest elevation, a distance of 45 feet. Fortunately the lens was uninjured, but repairs will take up the entire summer, and will delay the use of the telescope to that extent.

DR. S. A. PAPAVASILIOU has sent us an intimation that he has resigned the directorship of the Service géodynamique de l'Observatoire d'Athènes.

PROF. L. L. DYCHE, of the Kansas State University, has reached San Francisco, *en route* for Alaska, to make arrangements for an expedition to the Pole, beginning next season, and planned to extend over three years or more. He will have provisions for a five years' absence, making the start from the northernmost whaling station.

THE U.S. Secretary of Agriculture has designated a Board, of which Mr. B. Killen, of Oregon City, Ore., chairman of the Board of Regents of the Oregon Agricultural College, and Mr. Evans, of Washington, D.C., are members, to go to Alaska, to investigate the needs of an agricultural experiment station in that territory, and to secure data incident to the establishment of such an institution.

THE Cagnola prize of 2500 lire (100*l.*) and a gold medal having a value of 500 lire (20*l.*) was awarded to Prof. Dr. Ferdinando Sordelli last year for a memoir entitled, "Studi sulla Vegetazione di Lombardia durante i Tempi Geologici," which has just been published as volume xiv. of the *Atti della fondazione scientifica Cagnola.*

PROF. CHARLES L. BRISTOL, of the New York University, and three of his students, with Prof. Tarleton H. Bean, Superintendent of the Castle Garden Aquarium; Dr. W. M. Rankin, of Princeton, and Prof. Wm. H. Everett, of the New York University, sailed from New York for Bermuda on June 3, as a biological expedition. Besides collecting specimens, the party will try to discover a suitable site for a permanent station for the study of marine life. General Russell Sturgis has offered the University a site on his estate at Hamilton.

THE Commercial Museums at Philadelphia, containing industrial exhibits from all the nations of North and South America, including over 75,000 samples of natural produce and industrial products, was opened on June 2, by President McKinley, in the presence of many of the ambassadors of the different American countries, and of special delegates from others. The exhibition is the largest and most complete in many respects that has ever been held. An International Commercial Conference was held in connection with the opening of the museums, under the presidency of Dr. William Pepper, of Philadelphia.

THE United States Weather Bureau has been conducting experiments with kites flown at distances of from one to two miles above the earth, and now it is claimed that it is possible to forecast the weather for a period sixteen hours longer than at present, and more accurately. It is said that the fact has been established that shifting of the wind occurs at the height of a mile above the earth's surface from twelve to sixteen hours before the same change of direction occurs on the surface. Researches by means of high-flown kites and aeroplanes have now been prosecuted so far as to warrant the expectation that within six months the United States Weather Bureau will be able to construct a telegraphic synchronous chart based on conditions of the atmosphere one mile above the earth. This chart will cover the region between the Rockies and the Alleghanies at the outset.

A BOTANICAL society has recently been established at Perth, West Australia, and has been given the designation of the Mueller Botanic Society, as a tribute to the memory of the late Baron von Mueller, who spent the best part of his life in investigating the plants and other products of Australia. Sir John Forrest has been elected president of the new Society; Mr. Wittenoom and Mr. Leake, vice-presidents; and Mr. Skews, secretary.

FURTHER reports of the earthquake in India, on June 12, show that the disturbances were felt over a very extensive area. Considerable damage was done to public and private buildings at Calcutta, and many places in the provinces of Bengal and Assam have suffered very severely. The complete breakdown of telegraphs and other means of communication delayed the reports from Assam regarding the effects of the earthquake in that province. They are now, however, coming in, and present a terrible state of affairs. Reuter reports that at Shillong the shocks of earthquake were so severe and prolonged that everything was levelled with the ground, and many people lost their lives. Gauhati is in ruins. The roads are broken up into chasms, and the railway has disappeared, but no lives were lost. At Goalpara, on the Brahmaputra, the earthquake produced a wave of water which destroyed the bazaar and all pakka buildings. The country is covered with fissures, from which mud and sand are constantly spurting. At Dhubri all pakka buildings have been demolished. The river bank has subsided, the country is flooded, and the crops are ruined. Both at Goalpara and Dhubri there has been serious loss of life. Several places

are cut off from communication, and nothing has been heard from them. Throughout almost the whole of the province of Assam bridges have been destroyed and the roads rent with fissures, so that communication by road is impossible, and the telegraph cannot be used. Further information from Assam shows that the earthquake was slight in Silchar, Kohima, Manipur, Dilbrugarh, and Sibsagar; violent at Barpeta, Nowgong, and Mangaldai, in addition to the places already reported. The Chief Commissioner estimates the mortality from the earthquake in the Cherra Hills at between 4000 and 6000, but details have not yet been received.

THE semi-centennial anniversary of the American Medical Association, held at Philadelphia June 1–4, was attended by President McKinley. About 2500 delegates were present. Dr. Nicholas Senn, of Chicago, presided, and Dr. Nathan S. Davis, of the same city, founder of the Association, was also present. Several hundred papers were read before the various sections.

DR. ARTHUR G. BUTLER, writing in the *Zoologist* (June 15), describes some observations which tell against the assertion that birds build their nests by imitation, and that the reason why many of them at the commencement of the season trifle with building material for some time before they produce a satisfactory structure is that they are unable at once to remember exactly what the character of the nest was in which they first saw the light of day. Different hen canaries, reared in the usual square box of a London breeding-cage, were turned loose by Dr. Butler in aviaries in which no typical finch-like nest existed, and they reproduced nests nearly resembling those of their wild ancestors. A still more convincing proof of the instinctive building habit in birds is given. Dr. Butler turned loose a canary, also cage-bred, in one of his aviaries, late in April. The bird took possession of a square box hung high up on the wirework, and had almost completed a nest therein when it was disturbed. Afterwards it commenced and completed an elaborate cup-shaped nest in a dead bush.

WE are very glad to see that the value of experimental work in agriculture is becoming more widely recognised by British farmers. That this is so, is shown by a petition which agriculturists of the Dunblane district of West Perthshire have sent to the Board of Agriculture in favour of experimental farms. The petition points out that in the United States there are about fifty-four agricultural experimental stations, apart from colleges, receiving Government support to the extent of from 3000*l.* to 4000*l.* each; in France, Denmark, Norway and other countries, large sums are annually expended by Government in aid of agricultural education and research; and in Germany, about a dozen colleges and experimental stations combined receive an average Government grant of about 3000*l.* each. In comparison with this is the fact that in Great Britain the Government grants amount to only about 8000*l.*, which is distributed among eleven colleges and three dairy institutes, and is mostly expended on teaching. The petition goes on to state that a great deal of money is annually lost to farmers through the misapplication of manures, as well as by the injudicious feeding of stock; and though much knowledge has been accumulated by wise and observant farmers, yet this knowledge is being continually lost through want of proper record and confirmation. While some of the suggested remedies for agricultural distress are objectionable, it is believed that a judicious and extended system of experiment would tend, on the contrary, by teaching farmers how to grow larger crops with the same or less expenditure, to increase the supply of home-grown food without increasing its cost.

THE retirement of M. Folie from the directorship of the Brussels Observatory has led to an appeal in both Houses of the Belgian Parliament for the separation of the meteorological service from that of astronomy, which is now the case in nearly all other countries. *Ciel et Terre* of June 1 contains a verbatim account of the speeches made in favour of the separation. The Royal Observatory of Brussels was established in 1826 by A. Quetelet, who presided over the International Maritime Conference at that place in 1853, and whose works on the climate of Belgium, and the "Physics of the Globe" are still considered as models of scientific discussion. The Belgian Meteorological organisation, although dealing with a comparatively small area, is one of considerable importance in the European system. It issues a daily weather chart based upon the reports received by telegraph from nearly fifty inland and foreign stations, a volume referring specially to the observations made at the Observatory, by self-recording and other instruments, and a monthly *Bulletin* containing a summary of the observations made in the country. It supplies daily weather telegrams to the various fishing stations, and storm warnings, when necessary, based on the telegrams received from the Meteorological Office in London, and also issues notices to collieries in the event of unusual falls of the barometer.

MR. H. C. RUSSELL, C.M.G., F.R.S., sends us a description of a very brilliant aurora observed in lat. $47\frac{1}{2}°$ S., by Captain Hepworth, of the R.M.S. *Aorangi*, on April 20, while on a voyage from the Cape to Sydney. He thinks the aurora is by far the finest that has ever been seen in the southern hemisphere. It was first observed as a diffused light over the southern arc of the horizon at 6.30 p.m. From this light horizontal flashes soon spread, and flashed upward in every direction, increasing in length and brilliancy, until, at 7.30 p.m., they were shooting across the sky to within 30° of the northern horizon. At 8.30, Captain Hepworth noted that "an arch of bright green light, fading off into yellow, formed over the southern horizon, rose rapidly to a higher and higher altitude, and was followed by similar arches in regular sequence, until there were six distinct arches, their apices being from 10° above the southern horizon to 60° above the northern horizon. They were formed of vertical bands of light from 5° to 20° wide, bright green and yellow at their tops, and of a rosy hue at their bases. Subsequently these arches changed their shapes in all parts of the sky, others forming, but some kind of sinuous curve was always preserved, except in one or two cases. At 9 o'clock a circle formed round the zenith, having a rotary motion, this circular motion having been apparent in all the formations hitherto mentioned. A special feature in this display should be mentioned. These formations all had a westward movement. After 9.15 the aurora was less brilliant, but burst into greater activity a few minutes afterwards, more especially in the northern semicircle. The display lasted until 9.45, gradually fading after 9.30." Mr. Russell adds to this description some interesting remarks on the supposed connection between auroræ and the weather.

THE last number of the *Izvestia* of the Russian Geographical Society contains a dramatic account of M. Pastukhoff's second ascent of the Elbruz. The two summits of this Central Caucasus peak attain, as is known, the altitude of 18,470 feet and 18,340 feet respectively, and consist of two funnel-like craters, situated nearly two-thirds of a mile from each other. The northern and eastern slopes of the peak are covered with a thick *névé*, from which originate fourteen large and several smaller glaciers; they cover an aggregate surface of about sixty-seven square miles, and attain a great thickness, fissures 700 feet deep having been measured in one of them. The lowest level reached by the glaciers is 7640 feet. During the ascent, M. Pastukhoff's companion and one guide were disabled, and had to be left behind, and two nights had to be spent on the glacier,

under the protection of some stone blocks. While the Russian alpinist continued climbing, with one man only, a snowstorm overtook them; and though M. Pastukhoff reached the summit, he could only catch an occasional glimpse of the opposite border of the crater-like funnel, and leave there a tin box, with thermometers, under a big stone. The downward journey was terrible. M. Pastukhoff and his help lost their way, and when the night came they were on a glacier, which they could not identify, surrounded by a labyrinth of fissures. They had again to spend the night in a hole burrowed with their sticks in the snow, covered by one overcoat only, after having had no food all the day. Happily, next morning they fell in with the other guide, who had hastened to go down to a safer place as soon as the snowstorm began, and had carried with him a few biscuits. They soon found their way to the end of the Azau-glacier, where the other members of the party were anxiously waiting for their return.

THE Wellington Caves, situated in the vicinity of the town of Wellington, New South Wales, are remarkable for the large number of fossil remains of extinct animals found in them. The caves were discovered in 1830 by Sir Thomas L. Mitchell. The valley in which they are situated is bounded on each side by hills of limestone rock, rising to a height of about 100 feet on the eastern side, and considerably higher on the other. The floors of the caves are in places thickly covered with loose, dry, red earth which rises in fine dust at every step. At first it was anticipated that numerous fossils would be found in the earth, but after repeated digging only a few fragments of bone, apparently of the kangaroo, were obtained. About 80 feet to the west of the Great Cave is the Breccia Cave, one of the most important and interesting, from a scientific point of view, yet discovered in Australia. The floor is of red earth of considerable depth, the upper portion containing large numbers of bones. In this cave was found a skull, which proved to be the head of an enormous kangaroo. This led Owen to pronounce the opinion that there would be found the remains of a large carnivorous animal, which had been contemporary with the gigantic kangaroo, his view based upon the fact that the herb-eating marsupial must have had a natural enemy. This prediction was subsequently verified, for in 1887 a skull and several jawbones were found, the teeth being in an excellent state of preservation. These remains were ascertained to be those of a lion of a savage and carnivorous nature. It was also a marsupial, carrying its young in a kind of pouch. Other skulls of the animal have been found, but a complete skeleton has yet to be obtained. Mr. Gerard Krefft, who for several years was curator of the Sydney Museum, took much interest in the work of exploring the Breccia Cave, and under his superintendence many hundreds of fossil remains were recovered, not a few of which are now in the British Museum.

THE Superintendent of the National Zoological Park states, in the Smithsonian Report (1895) which has just been distributed, that a spontaneous outbreak of rabies occurred in one of the enclosures for foxes. This is interesting from a scientific point of view; especially as the animals were in perfect health, and, so far as is known, the disease could not have been introduced from without. A single case at first appeared, and this inoculated the entire cage of foxes, seven animals in all being lost. This curious phenomenon is of great interest as bearing upon the sporadic appearance of rabies in the dog.

MR. LAURENCE LAMBE, in a paper on the sponges of the Atlantic coast of Canada, which has just appeared in the *Transactions* of the Royal Society of Canada, gives a complete catalogue with descriptions of the marine sponges hitherto obtained from this coast and from the river and Gulf of St. Laurence. The list embraces thirty-one species, of which seven are new to science.

THE first of a series of contributions to Canadian botany, by Jas. M. Macoun, Assistant Botanist to the Geological Survey of Canada, appeared in vol. vi., No. 1, of the Canadian *Record of Science*, published January 1894. Ten of these papers have been published, the last in the number of the *Record of Science* which has just been issued. These contributions from the herbarium of the Geological Survey, form an addendum to Prof. Macoun's "Catalogue of Canadian Plants," the first part of which was published by the Survey in 1882, the last (Part vi.) in 1892. The first five parts, composing 1050 pages, include all the species of Phanerogams and Vascular Cryptogams known to occur in Canada, with their distribution. Part vi. deals with the Musci. The notes, which have from time to time appeared in the *Record of Science*, are records of species new to science or to Canada, and notable extensions of the known limits of species already recorded. As revisions of American orders and genera have been published, the necessary changes have been made in Canadian nomenclature, so that by means of the papers printed in the *Record of Science*, our knowledge of Canadian botany has been kept strictly up to date. Each of the ten papers already published averages about ten printed pages, with the exception of the last, which is about twice that size. Seventy-eight additions to the Canadian flora have been recorded in these notes, and the range of several hundred species has been greatly extended. They have been reprinted by the Geological Survey of Canada, and may be procured from the Librarian of that department at five cents per copy.

MR. T. H. HOLLAND, of the Indian Geological Survey, whose investigations of the Gohna landslip in 1894 had such successful results in the prevention of subsequent disasters, has now produced a detailed report on a similar subject. The hill-slopes about Naini Tal appear to be in some danger of slips, as in places the divisional planes of the slates dip in the same direction as the surface of the ground and at an angle which, though actually high enough to make slipping possible, is sometimes less than that of the hill-slope: such a condition is obviously extremely dangerous. The investigations include a full contour-survey and a geological mapping of the district, as well as a determination of the angle of repose for the various constituent rocks. The most dangerous sites are indicated, and suggestions for protective operations made where they are worth undertaking. A large number of plates illustrate the report, which is of importance, not only to the residents at Naini Tal, but to all interested in the general phenomena of landslips.

AMONG the articles and other publications which have come under our notice during the past few days, are the following:—Bog-bursts, with special reference to the recent disaster in Co. Kerry, by Mr. R. Lloyd Praeger, in the *Irish Naturalist* for June. Mr. Lloyd Praeger was a member of the Committee appointed by the Royal Dublin Society to investigate the bursting of the Knocknageeha bog in December last (see vol. lv. p. 254), and his paper is a summary, with illustrations of the observations made.—The presidential address, on "The Evidence for the Existence of Man in the Tertiary Period," delivered before the Geologists' Association at the last annual general meeting, by Mr. E. T. Newton, F.R.S., is printed in the May number of the Association's *Proceedings*.—"De verhouding van het gewicht der hersenen tot de grootte van het lichaam bij de zoogdieren," by Dr. Eugène Dubois. This paper, published by the Amsterdam Academy of Sciences (*Verhand. Kon. Akad. v. Wetensch.* Dl. V. No. 10, April), brings together and discusses a large number of observations of the relations between the weight of the brain and total weight of many animals.—The eighth contribution of "Materials for Flora of the Malayan Peninsula" is made to the *Journal* of the Asiatic Society of Bengal (vol. lxv., Part ii., No. 3, 1896), by Dr. George King, F.R.S., Superintendent of the Royal Botanic Garden, Calcutta.

—An interesting paper on early magnetic observations, "Die Anfänge der magnetischen Beobachtungen," contributed to the *Zeitschrift der Gesellschaft für Erdkunde* (vol. xxxii. part 2), by Prof. G. Hellmann, has been reprinted and is now published as a separate paper by W. H. Kuhl, Berlin.—Report on the progress of the Survey of Tides and Currents in Canadian Waters, by Mr. W. Bell Dawson. The report contains some valuable tidal data, and also the results of a general examination of the currents in the interior of the Gulf of St. Lawrence and the Straits connecting it with the Atlantic Ocean.

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*, ♂ ♀) from South Africa, presented by Mr. J. W. Lincker; a Squirrel Monkey (*Chrysothrix sciurea*, ♀), a Yellowish Capuchin (*Cebus flavescens*, ♀) from South America, presented by Mr. H. C. Fernando Rohé; a Vervet Monkey (*Cercopithecus lalandii*, ♀) from South Africa, presented by Mr. Alfred Beit; two Common Peafowl (*Pavo cristatus*, ♂ ♂) from India, presented by Colonel Stucley; a Rocky Mountain Sheep (*Ovis montana*, ♀) from North America, a Suricate (*Suricata tetradactyla*) from South Africa, two White Ibises (*Eudocimus albus*) from South America, a Pennant's Parrakeet (*Platycercus pennanti*), a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, deposited; two Red Kangaroos (*Macropus rufus*, ♀ ♀), two Peaceful Ground Doves (*Geopelia placida*) from Australia, purchased; a Thar (*Capra jemlaica*, ♀), a Great Kangaroo (*Macropus giganteus*, ♂), a Rufous Rat Kangaroo (*Œpyprymnus rufescens*, ♀), two Squirrel-like Phalangers (*Petaurus sciureus*), a Short-headed Phalanger (*Petaurus breviceps*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE.—Dr. Gill, in his report for the year 1896 to the Lords Commissioners of the Admiralty, sums up the work accomplished during the past twelve months. With regard to the McLean telescope, this is expected to be completely installed and in full working order before the end of the present year. During the last few years, Dr. Gill has somewhat necessarily restricted the amount of observational work in order to make more progress in the computation and publication of many arrears, and it is satisfactory, then, to hear that it has now become possible to again resume a programme of activity. Several important publications have been concluded in the last twelve months. Among them may be mentioned Vol. ii., containing a determination of the solar parallax and mass of the moon, from observations of Iris, Victoria, and Sappho, made in the years 1888 and 1889. Vol i. is also practically complete. The first volume of the Cape Photographic *Durchmusterung* is also ready for distribution, Vol. ii. being in course of printing. The observational work with the transit circle, equatorials, and astro-photographic telescope has been very considerable, and it may be mentioned that all the catalogue plates, with the last-mentioned instrument, have now been obtained. Out of the 230 chart plates, 169 have been satisfactorily exposed. The 7-inch equatorial has also been very busy in the hands of Mr. Innes, and, besides several new variables, 104 new double stars have been discovered. Dr. Gill refers also to the increase in staff and the necessity for a reversible transit circle for refined fundamental work, and mentions that these proposals have been favourably considered by the Lords Commissioners of the Admiralty and of Her Majesty's Treasury.

ZODIACAL RADIANTS OF FIREBALLS.—A remarkable feature about the appearance of slow-moving fireballs is that, as Mr. Denning has pointed out, they are directed from radiants in the western half of the sky and in the neighbourhood of the horizon. A further communication by him to the *Monthly Notices* for May, tells us that not only the most prominent, but the majority of the radiant points determined by observation are found to apparently congregate in a line approximately coinciding with the position of the ecliptic. Although there are a few exceptions to this law, Mr. Denning is nevertheless confident that there is sufficient weight of evidence which is of a suggestive and significant kind. In favour of this view, he gives a table of the observed facts which strikingly corroborate the idea advanced. He draws attention to the importance of accurately recording the directions of flight, and apparent paths among the stars of these bodies when they become visible, and of accumulating data which are necessary for trustworthy results to be based on them. All of us are aware of the great difficulty of accurately observing these strangers in our atmosphere, which come and go at generally most unexpected moments. They are, nevertheless, worthy of special study, and it would be very interesting if they were found to be revolving not only in direct orbits, but in orbits with small inclinations like the Jovian family of comets, as is suggested by Mr. Denning.

THE ROYAL SOCIETY CONVERSAZIONE.

THE second soirée this year took place on June 16. It was very numerously attended, and was more than usually brilliant, as, in accordance with a suggestion made by the President, the officers and many of the fellows appeared in academic or levée dress, to show respect to the Queen's guests who had been invited. The chief exhibits were as follows:—

Electrical effects of uranium: Lord Kelvin, G.C.V.O., F.R.S.

Experiments on kathode rays and some analogous rays: Prof. Silvanus P. Thompson, F.R.S.

Signalling by Hertz waves, as practised by Dr. Oliver Lodge, in 1894, with a Branly tube of filings as receiver, and now adapted to a Kelvin recorder: Dr. Alex. Muirhead.

(1) A selection of dried plants from Tibet, collected by Captain Deasy and Mr. Arnold Pike, Captain Wellby and Lieut. Malcolm; (2) views near the lake, and in the Queen's Cottage Grounds, Kew, by Monsieur and Madame de l'Aubinière: The Director, Royal Gardens, Kew.

(1) Experiments with Röntgen X-rays; (2) experiments with kathode rays; (3) Experiments with oscillatory electrical discharges: Mr. A. A. C. Swinton.

Experiments illustrating a new method of controlling the electric arc in its application to photo-micrography: Mr. T. A. B. Carver, and Mr. J. E. Barnard.

Living specimens of *Proteus anguinus*, Laurenti.—(1) Male and female; (2) pigmented individual from cave; (3) young specimen to show the eyes: Mr. E. J. Bles.

Pelagic animals from the west coast of Ireland: Mr. E. T. Browne.

Specimens of electric figures: Lord Armstrong, C.B., F.R.S.

Stress effects produced by convective electric discharges: Mr. J. W. Swan, F.R.S.

Crystals of diamond, separated from carburised iron: Prof. Roberts-Austen, C.B., F.R.S.

Commensalism amongst marine animals: The Marine Biological Association.

Microscopic image, formed exclusively by diffracted light: Dr. G. Johnstone Stoney, F.R.S.

Examples of animal-forms peculiar to Lake Tanganyika: Mr. J. E. S. Moore.

Microscopic sections of teeth of fossil reptiles: Prof. H. G. Seeley, F.R.S.

Illustrations of the absorption of Röntgen rays by certain elements and their compounds: Dr. J. H. Gladstone, F.R.S., and Mr. Walter Hibbert.

Ancient Egyptian knives and lance-head of flint: Sir John Evans, K.C.B., Treas. R.S.

Models of orchids, by Miss Emett, from plants grown in the Royal Gardens: The Director, Royal Gardens, Kew.

(1) New species of British Mymaridæ (egg parasites) or "Fairy Flies"; (2) aquatic and terrestrial specimens, living: Mr. F. Enock.

Medal struck in gold, silver, and bronze, to commemorate the sixtieth year of the reign of her Majesty the Queen: Mr. Horace Seymour, Deputy Master of the Mint.

Two induction coil contact makers and breakers: Sir David Salomons, Bart.

Demonstration of apparatus for exciting high vacuum tubes for X-ray work: Dr. John Macintyre.

There were the following demonstrations with experiments, and lantern illustrations:—

Signalling through space without wires: Mr. W. H. Preece, C.B., F.R.S.

Photographs illustrating the arrangements of the 1896 eclipse expeditions at Kiö and Novaya Zemlya: Mr. J. Norman Lockyer, C.B., F.R.S.

PROFESSOR MENDELÉEFF ON THE HEAT OF COMBUSTION.[1]

DULONG'S formula, which gives the heat of combustion of different solid and liquid fuels, as depending upon their composition, is, as is known, $\phi = 81\,c + 345\left(h - \frac{o}{8}\right)$, c, h and o representing the percentages of carbon, hydrogen, and oxygen in the fuel.

If a general expression, $\phi = \mathrm{A}c + \mathrm{B}h - \mathrm{C}o$, be taken, the numerical value of the coefficient $\mathrm{A} = 81$ must be maintained, because it corresponds to pure charcoal, and all known data (from 8140 to 8060) prove that the figure 81 must really be taken for each per cent. unit of carbon in the fuel (the accuracy of the measurements being within the limits of from 1 to 2 per cent. of the total heat of combustion). For hydrogen, however, the coefficient $\mathrm{B} = 345$ cannot be maintained, because it has been obtained out of data relative to the burning of gaseous hydrogen, while in usual solid or liquid fuel the elasticity of the gas is lost; its hydrogen must be considered as if it were liquefied, and consequently B must not be, according to what is known, more than 300 (admitting, as is usually done, that the water obtained during combustion is in a liquid state).[2]

In order to find the true coefficients suitable for practical purposes, Mendeléeff took the figure $\phi = 4190$, which is quite correct (within 1 per cent.) for pure cellulose, as also the average from 79 most complete measurements for fat coals (by Maler, Alexeyeff, Damski, Diakonoff, Miklaschewski, Schwanhöfer, and Bunge), and the average for naphtha fuel, and he has found:

$$\phi = 81\,c + 300\,h - 26\,(o - s),$$

which formula represents,[3] with an accuracy of from 1 to 2 per cent., the heat of combustion of pure charcoal, coke, coals, lignites, wood, cellulose, and naphtha fuels; of course, it applies to the best determinations only, especially to those which were made in a calorimetric bomb, where the error is less than 1 to 2 per cent.[4]

This formula is an approximate empirical expression of facts; but it corresponds at the same time to the numerical value of the coefficient B for hydrogen, which could be expected from theoretical considerations.[5]

THE SCIENTIFIC REQUIREMENTS OF COLOUR PHOTOGRAPHY.

ON Tuesday evening, June 1, in the Examination Schools, Oxford, Captain W. de W. Abney, C.B., F.R.S., gave the sixth Robert Boyle Lecture before the Oxford University Junior Scientific Club. The President, Mr. R. A. Buddicom, was in the chair, and about 800 members and their guests were present.

The subject chosen by Captain Abney was "The Scientific Requirements of Colour Photography." The following is an abstract of the lecture:—

Colour photography and photography in natural colours are two distinct methods of arriving at the same end, namely, the production of a picture of objects, coloured as they naturally appear to the eye. Both have been accomplished and depend on the application of science, but in the case of the former additional knowledge is requisite of the mode of action of the retina and of theories of colour vision.

In colour photography the theory of colour vision usually adopted is the Young-Helmholtz three-colour theory, in which red, green and blue are selected as primary colours, and not the red, yellow, blue of the artist. Captain Abney pointed out the difference between colour and colour sensation, and placed his colour sensation curves before the audience. These curves enable particular coloured screens to be selected, so that if transparencies from three photographs of the same object, taken one through an orange screen, one through a green, and one through a blue, be each illuminated by its own peculiar coloured light, and the three images be superimposed, the effect is to reproduce a picture of the object in its original colours. The colours of the screens used for taking the negatives must not be such as to allow only monochromatic light to pass. Thus the red screen must allow some orange, the green some yellow, and the blue some green, so that the lights through the three screens overlap somewhat.

The viewing screens, on the contrary, should be as nearly monochromatic as possible. By these means Mr. Ives has, in his chromoscope, been able to present to view photographs of natural objects in the colours in which they appear to the eye.

The next process described was that of Dr. Joly, of Dublin, who, basing his work on the same theory of colour vision as Mr. Ives, reproduces in colour by means of a single negative. This method is essentially founded on what may be called a happy imperfection of the eye. The human eye is incapable of separating points which lie very close to one another. In an engraving, the black lines, close together on a white surface, blend with the white surface to form shades of grey. Dr. Joly's method is to rule lines 1/200 inch broad on a transparent screen, touching one another and being coloured alternately red, green and blue. The lines are of such a depth of colour that the mixture, if made by rotating sectors, would appear white or grey. This screen is used for viewing. To make the negative another exactly similar screen is placed in front of the plate, but the colours of the lines on this differ, just as Mr. Ives' coloured screens for taking the negatives differ from his viewing screens.

When the negative is taken, a transparency is made from it, and the viewing screen is placed behind it, so that the red line covers the place through which the orange negative was taken, and so on. Then, and not till then, the picture appears in its natural colours.

Instead of using transparencies and coloured films, transparent inks may be used to produce pictures by three printings.

The next process described was the oldest, namely, the production of colour by the action of light itself. The present year is its jubilee. Becquerel found that if, instead of iodising a plate, he chlorinised it, and then exposed it to white light, it gradually assumed a violet tint, and if, in this state, he exposed it to the spectrum he was able to obtain the colours of the spectrum on it.

Abney, some years ago, showed that the red tint was due to the lavender-coloured material taking up oxygen, whilst at the violet end the subchloride became further reduced: thus the big molecules formed by the addition of the oxygen vibrated slower, whilst the abstraction of chlorine gave smaller ones vibrating quicker. Since he was able to get the same effect on collodion plates, it is not probable that the colours are due to stationary waves, because, if so, they could only be viewed by reflected light. Unfortunately, however, these colours, from the very manner in which they were produced, were not permanent, and no method has been devised for fixing them.

The last method Captain Abney described of obtaining photographs which showed colour, but not coloured photographs, was that of Lippmann, who found that if, by means of reflection, he obtained stationary waves in the film, on development the silver was deposited between the nodes. On reflecting light from such a "noded" plate, the proper light alone was reflected, and the photograph, viewed at a particular angle, appeared in its natural colours. If looked at by transmitted light, these photographs have merely the appearance of ordinary negatives.

The proceedings closed with a vote of thanks to the lecturer, proposed by Prof. Burdon Sanderson, and seconded by Mr. A. F. Walden.

THE INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

THE International Congress on Technical Education, opened by the Duke of Devonshire at the Society of Arts on Tuesday, June 15, was continued on the three following days. Many important papers were read, and there was a large attendance of delegates from the continent and abroad. We have extracted from the *Times* the subjoined brief reports of a few of the papers read and the discussions which took place upon them.

[1] Translated from the *Journal* of the Russian Chemical and Physical Society, vol. xxix. fasc. 2, 1897, pp. 144. (Minutes of meeting of February 18, 1897.)

[2] Maler has also adopted that coefficient, taking $\mathrm{C} = 30$.

[3] The percentage of sulphur was not determined in each measurement, and consequently the coefficient $+26$ is determined only approximately.

[4] If the water which is formed during combustion is represented, as it is in reality, in the shape of steam, then 600 aq must evidently be deducted from ϕ; aq representing the weight of water obtained from the combustion of one unit of fuel.

[5] In those cases where different values of ϕ were received for the same composition of coal, the discrepancies could be explained by errors of measurements; there was no foundation to suspect isomerism. A good deal of the now prevailing incertitude is also due to the incomplete data relative to the amount of combustible sulphur.

Several papers on the aims of instruction in chemistry were read on the opening day. In one paper Dr. Otto N. Witt, Professor of Chemical Technology at the Polytechnic School of Berlin, said he could not admit any fundamental difference in the methods of research of pure and applied chemistry, consequently he could not admit the necessity for a difference of instruction for the two. A well-organised instruction in pure chemical science would, in his opinion, be the best preparation of any young chemist for his future career. He held that schools for producing specialists were not wanted; for specialism came as a matter of course in later life. Chemists were needed who embraced their science as a whole, and who were incapable either of separating practice from theory or theory from practice.

Dr. H. E. Armstrong urged the need of better organisation in regard to instruction dealing with the preparation of the soil for agricultural purposes.

Dr. Gladstone, in the course of a paper on "The Teaching of Chemistry in Evening Continuation Schools," said that when the evening school was situated in the neighbourhood of factories it would be allowable and even desirable that the illustrations should be chosen with some reference to the prevailing industry.

Sir H. Roscoe, in opening a general discussion on the subjects dealt with in the foregoing papers, pointed out that what we in England suffered from was the failure of our manufacturers to see, as they ought to see, the importance of the highest scientific training for their *employés*. Recently he visited some large colour works near Frankfurt, where 100 men were employed, including many highly-trained scientific chemists who had devoted years to original research with a view to making new discoveries. One *employé*, who received 1000*l*. a year, worked for several years without producing any results. But eventually he made a discovery which repaid the firm ten times over and placed an entirely new branch of manufacture in their hands. Scientific teaching had taken up a sound position already, and if manufacturers would only appreciate its value we could turn out scientific men as well as any country in the world.

This view was given support by a paper on "The Teaching of Chemistry," by Prof. G. Lunge, of Zurich, read by Sir H. Trueman Wood. The writer held that, to raise English chemical industry to the foremost rank (which was disputed to it at present in several important branches), it was necessary that the technical management of chemical factories should not be left in the hands of "rule-of-thumb" men, but should be intrusted to real chemists. These men should have a much fuller education than the majority of chemists seem to obtain at present in Great Britain, which meant that they must spend more time and money on their training than they generally did. At college the student should receive a thorough training in scientific chemistry, taking this in its widest meaning, not merely as a "testing" exercise. Next to this, but not to the same extent, he should be taught physics, mineralogy, technology, mechanics, and the elements of engineering. As to whether foremen or even the common workmen should possess a certain knowledge of chemistry and technology, such as may be imparted at Board schools or at night classes for adults, Prof. Lunge was afraid that such knowledge was quite useless to ordinary workmen, who had simply to do as they were told, and who might do more harm than good by trying to apply a superficial idea of the nature of the operations which they had to perform, without possibly having a real insight into them. He did not even think that, apart from isolated exceptions, such knowledge was much good to the foremen, whose duty it was to carry out their instructions and to see that the men did their work as prescribed by the staff, but who were not to meddle with the chemical process itself.

Prof. Silvanus P. Thompson, in discussing the paper, said there should be a distinction between the different branches of the subject. He urged that where a great industry was localised science should be applied to that industry, and an institute should be put there devoted to monotechnical rather than polytechnical instruction. Training in research was absolutely necessary, and specific research should not be undertaken too soon by students who had not been taken through an all-round course in chemistry.

Mr. G. R. Redgrave, Chief Senior Inspector Science and Art Department, read a paper giving an historical retrospect of "The Intervention of State in Secondary Technical Education," in the course of which he urged that something of the nature of the German Realschule, but with a far larger proportion of practical science work and manual training, should be our model for the secondary school in this country.

On Wednesday, June 16, Sir Philip Magnus, in a paper on "Theory and Practice in Trade Teaching," referred to the difficulty of determining the true relation of theory and practice in teaching the technology of any trade, and in the Technical Instruction Act, which expressly forbade the teaching of the practice of a trade in any technical school. But in the great majority of industries the practice of the trade was best acquired in the factory and shop, and the instruction of the technical school should be supplementary only to the experience obtained in commercial work. By this principle nearly all our technical classes were regulated. Although a technical school might be equipped almost as completely as a trade shop the equipment served a very different purpose. Its object is the production of intelligent workpeople, and not the production of saleable commodities. The practice a student obtains in a technical school was intended to enable him to understand appliances of his trade, and to use them with care and judgment.

Mr. S. H. Wells, Principal of the Battersea Polytechnic, pointed out that the greatest of all difficulties in connection with technical classes was undoubtedly the provision of satisfactory and efficient teachers. The first and most natural qualification of a teacher of technical classes was that he should possess a practical knowledge—acquired in the factory or workshop—of the subject to be taught; the second, that he should possess a sound knowledge of the arts and sciences applicable to the subject; and the third, that he should be able to impart his knowledge to others, to arrange a syllabus of instruction, to manage a class, in a word, to teach.

Prof. Ayrton gave an account of the Central Technical College, South Kensington. He remarked that the facilities for technical instruction in London were increasing every day, but a system of coordination was greatly needed.

Prof. Silvanus Thompson urged the coordination of educational institutions from the highest to the lowest. Dr. Garnett said that if artisans were to be attracted to technical classes the teachers must be acquainted with the practical details of the trades to which the artisans belonged. It was difficult to find theoretical and practical knowledge combined in one man. The presence of practical workmen he had found a great advantage when holding his classes. Prof. Viriamu Jones (Cardiff) believed that artisans would ultimately avail themselves of the best instruction to be obtained in each science bearing on their trade. They would feel that teaching by specialists was better for them than teaching from those who might have learnt but little of the subjects. Mr. Reynolds (Manchester) pointed out the wasteful overlapping that prevailed in connection with technical instruction. The Technical Instruction Act, which forbade the practice of a trade being taught in technical schools, was practically a dead letter in Lancashire, and deserved to be. Prof. Chatterton (Madras) said that the great difficulty in connection with the technical schools in the Madras Presidency was to obtain efficient teachers. Mr. Mundella, M.P., said that proper elementary education was indispensable before working men could derive benefit from special technical instruction. Parliament must raise the limit of age for compulsory attendance at elementary schools to that which prevailed in other countries. If his students had not been well educated in elementary subjects the science master was called upon to make bricks without straw.

The Chairman, Major-General Sir J. Donnelly, in concluding the discussion, referring to the interpretation of the Technical Instruction Act, said technical instructors might teach how a thing was done, but not carry their training so far as to give the rapidity and dexterity of manipulative skill required for the craftsman or journeyman. Looked at in that way, there was no difficulty in working the Act.

Mr. Mundella, M.P., in introducing Prof. T. V. Diefenbach, to read a paper on "Technical Education in Würtemberg," referred to the marvellous progress made by the kingdom of Würtemberg during the last forty years. A commission from England, which visited Würtemberg to inquire into their system of technical education, reported that they had seen no part of Europe more progressive than Würtemberg, and they were assured that there was not a single pauper in the whole country. He wished he could say the same of England.

Sir Joshua Fitch then read a paper on "Some Limitations to Technical Instruction," in which he entirely admitted that our

school instruction had long been too bookish, too little practical, and that the friends of technical instruction were fully justified in calling attention to the grave deficiencies in our system, especially to the want of sounder teaching in physical science and of better training in the application of those sciences to the enrichment of the community and to the practical business of life.

Prof. Oscar Pyferven, of the University of Ghent, who represented the Belgian Government, read a paper on "L'Enseignement Professionnel et l'Initiative Privée en Belgique"; and M. E. Sève (Consul-General for Belgium) read a paper on "Technical and Commercial Instruction in Belgium."

Prof. Wertheimer, principal of Merchant Venturers' Technical College, Bristol, read a paper on the influence of various examining bodies on the progress of technical and commercial education in England. He held that it behoved them to watch closely any attempt to establish new examinations. The technical instruction committees of some County Councils were already instituting examinations of their own; in a very few cases these might be necessary to meet special local requirements. But, as a rule, they were not needed, and it would be wiser to endeavour to modify existing examinations, if necessary, rather than to establish new ones.

On Thursday a paper by Mr. Quintin Hogg, on "Polytechnics," was read by Dr. William Garnett, who also gave an account of the work of the Technical Education Board of the London County Council. In commenting upon the latter paper, Sir John Lubbock said that too much of the money went to the elementary and too little to the higher training of those who were to be the leaders of industry.

The next paper was on "Reforms in the Organisation of Technical Education," by Prof. Silvanus P. Thompson, F.R.S., who said that the provision made on the continent for the higher training in chemistry might be understood from the fact that the entire establishment of the Regent Street Polytechnic, chemical laboratory, gymnasium, swimming bath, theatre, kinematograph, and all, might be accommodated within the space provided for the chemical laboratory alone in the polytechnic at Munich. The chemical laboratory of the polytechnic at Zurich exceeded in contents the whole of the technical schools at the People's Palace. The chemical laboratory of Berlin was larger than the whole building of the City of London College. The physics laboratory at Zurich was considerably larger than the whole building of the Finsbury Technical College, and the cost nearly twice as much.

The remainder of the papers on Thursday dealt with commercial education, the organisation of examinations, and the development of technical instruction in secondary schools.

The concluding session of the conference, held on Friday last, was devoted exclusively to the consideration of papers by ladies on a variety of aspects of technical and secondary education. Mr. Mundella, M.P., presided.

Miss Alice Mitchell read a paper on the "Teaching of Domestic Economy in Girls' Secondary Schools." In the high schools she thought the great failure was the absence of the practical side, for all schools suffered from the want of laboratory facilities.

A paper was read by the Countess of Warwick on "Technical Education in Rural Districts." She said she had undertaken the task believing that a careful development of the subject might help not a little to stay the depopulation of our villages. An intelligent appreciation of natural phenomena and natural laws, when applied to agriculture, might go a long way to relieve the depression from which country districts were so keenly suffering. The elements of chemistry and physics, geology, botany, and zoology might be taught with great advantage to the future farmer or practical agriculturist. We should no doubt some day have a rational system of education, and not a disjointed one, as at present, when due regard would be paid to the co-ordination of subjects of instruction. At present, the great want was co-operation in all branches, but this was likely to remain while every branch of education was under a separate and distinct authority, often antagonistic to each other and encroaching on one another's grounds. In the same town they might see the voluntary schools, board schools, middle schools, grammar schools, and technical classes all being carried on under separate rate authorities, who have no regard for each other's work, and consequently overlapping each other's efforts, in many directions leading to waste of time, money, and energy. District technical schools should be opened within given areas, or a technical side to existing schools be developed; or, perhaps better still, the schools of the whole district should be affiliated, with a technical school attached, for the use of the pupils from all. The money received by county councils for the technical education grant might be well spent in equipping such schools. If a plot of land could be attached to the technical schools, it would be very useful for the purpose of experiment and demonstration in the field.

At the close of a discussion, the Chairman said Lady Warwick's paper was so full of suggestions that it was impossible to comment upon them briefly. It involved educational reforms of the highest importance, and the first was that one public authority in each district should see that education was properly carried out. Lady Warwick had put aside the utilitarian view; nevertheless, this was a subject of considerable moment, both in town and country. Denmark was far ahead of us in agricultural matters, and sent to this country produce to the value of 10,000,000*l.* annually. It was an extraordinary thing that we should have to pay enormous sums of money to foreign countries for supplies which we ought to be able to provide much better at home. They were told that foreigners were more intelligent than our people; and although he did not believe that, we should educate our people and try to make them as intelligent, fruitful, and productive as their foreign competitors.

A large number of other papers were read before the Congress, but the limitations of space prevent us from referring to them.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Bacteria and the decomposition of rocks, by J. C. Branner. In criticism of the somewhat largely prevailing idea that bacteria are the cause of much of what is called the decay of rocks, it must be remembered that nitrifying bacteria not only do not penetrate the rocks themselves to any considerable depth, but they do not even penetrate the soil to a depth of more than three or four feet. Granites are, on the other hand, often decomposed to depths of more than 100 feet.—On Wellsite, a new mineral, by J. H. Pratt and H. W. Foote. This mineral occurs at the Buck Creek corundum mine in Clay Co., North Carolina, associated with albite, felspar, and hornblende. No crystals found exceed 2 mm. in length. They are monoclinic and twinned, brittle, with a vitreous lustre and no apparent cleavage. They are colourless and transparent or white, with a hardness of between 4 and 4·5, and a density of about 2·3. Chemically, it is a barium or calcium hydrated silicate corresponding to the formula $RAH_2Si_3O_{10}.3H_2O$, and is therefore allied to Phillipsite, harmotome, and stilbite.—The magnetic increment of rigidity in strong fields, by H. D. Day. The author employs extremely strong fields in order to bring out clearly the relation between magnetisation and the phenomena of magnetic rigidity. He shows that long after magnetic saturation has been reached the increase of rigidity due to increase of field intensity goes on, and that the limit of the latter is not reached even with the highest field intensities attainable. As the field becomes stronger, the increment of rigidity varies more and more regularly with the twist, the tendency being that in fields indefinitely large the increment of rigidity would be proportional to the twist applied.—The broadening of the sodium lines by intense magnetic fields, by A. St. C. Dunstan, M. E. Rice, and C. A. Kraus. The phenomenon of the magnetic broadening of the sodium lines discovered by Zeemann may be easily observed with the aid of Michelson's interferometer. Light from a Bunsen flame containing a sodium salt is sent on to a plate of plane glass which partly reflects and partly transmits it to a fixed and a movable mirror. The fringes produced in the telescope by their recombination are made less visible by the broadening of the line observed. The curve of visibility gives the amount of the broadening. In the most intense field the broadening is in the ratio of 1 to 1·7. It is proportional to the field intensity.—The relative motion of the earth and the ether, by A. A. Michelson. This was investigated by an interference experiment in which a beam of light was made to travel round a rectangle in a vertical E. and W. plane, and to return along the same path. If the ether near the earth's surface moves with the earth, and the ether above the atmosphere is stationary, there must be some difference of

velocity in the upper and lower paths, which would be indicated by a displacement of the fringes. No such displacement is observed, and hence we must conclude that either the ether is absolutely at rest everywhere, or that the earth drags it with it up to many thousand miles from the surface, or, lastly, that the length of all bodies is altered by their motion through the ether.

Bulletin of the American Mathematical Society, May.—Systems of continuous and discontinuous simple groups, by Dr. L. E. Dickson (read at the April meeting of the Society). This paper is in continuation of some results announced at the Buffalo meeting (August 31, 1896), and consists of four sections. § 1 enumerates the known systems of discontinuous simple groups; § 2 the systems of finite continuous transformation groups which are simple; § 3 gives an elementary deduction of certain groups in § 2, viz. the groups in the $l(2l+1)$ parameters, isomorphic with the general projective group of a linear complex in R_{2l-1}, and a proof of their simplicity; § 4 discusses the semi-simple linear homogeneous groups whose defining function is the sum of n determinants of order $q>2$. The contents of §§ 3, 4 were presented by Prof. Lie (February 19) to his class, and he stated that "the interesting result of § 4 was new, and not what one would have expected."—On the number of roots of the hypergeometric series between zero and one by Mr. M. B. Porter (read at the March meeting). Klein's solution was published in 1890 (*Math. Ann.*, vol. xxxvii.). Solutions by Hurwitz and Gegenbauer are given in the *Math. Ann.* (vol. xxxviii.) and the *Wiener Sitzungsberichte* (vol. c.^{2a}) respectively. The object of the present paper is to apply two theorems of Sturm (*Liouville's Journal*, vol. i.) to the solution of the problem.—Another paper, read at the March meeting, is by Prof. J. Pierpont on modular functions. This treats the subject from the point of view of H. Weber's Memoir, zur theorie der Elliptischen Functionen (*Acta Math.*, vol. vi. p. 329; *cf.* also his Elliptische Functionen und Algebraische Zahlen, 1891).—In the Notes are given the mathematical courses for the summer session at the Universities of Chicago, Leipzig, and Munich.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 1.—Contributions to the knowledge of the Urticaceæ and the Moraceæ, by M. Golenkin, with one plate. The inflorescence and the disposition of leaves are treated in this second instalment (in German).—A preliminary catalogue of the Lepidoptera of the province of Kazan, by L. Krulikovski, continued (in Russian).—Study of the embryonal development of *Gammarus pulex*, by Marie Rossyskaia-Kojevnikova, with one plate (in French).—Materials for the mycological fauna of the province of Smolensk, by A. Jaczewski (in French). The author has found in that province 550 species of fungi, out of which 408 are new for that region, and he gives the list of these species.—On the structure, function and evolution of the Nematocysts of Cœlenterata, by N. Iwanzoff, with four plates (in German). An elaborate work, made at the zoological laboratories of Naples and Villefranche, to be continued.—On the rotation of the earth, supposed to be fluid in its interior, by Prof. Th. Sloudsky, being a purely mathematical inquiry, continued from a previous number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media." By Joseph Larmor, F.R.S., Fellow of St. John's College, Cambridge. Received April 21.

This series of papers is mainly concerned with the development of electrical and optical theory on the basis that electricity is constituted of discrete atomic charges or electrons. It has been shown in the previous papers that the facts of electrodynamics require this hypothesis and are consistent with it. The hypothesis was arrived at from the point of view of the properties of the æther, the conception of the electron as a permanent strain-centre being a necessary feature of a theory of an elastic æther. This idea is here developed and illustrated by aid of a specification, on Lord Kelvin's lines, of a gyrostatic material structure which would possess the rotational elasticity characteristic of the æther, and at the same time contain such strain-centres. The conception of a medium of elastic solid type containing mobile discrete strain-centres is also touched upon, by way of illustration and contrast.

In the previous papers the relations of electromotive and optical phenomena in matter at rest had been developed on this basis. When the matter is considered as in motion through the æther, or when electric forces on matter are treated, we obtain a definite and sufficient basis of connection between matter and æther by assuming that the electrons are attached to the atoms of matter. On this basis the electric and optical relations of moving material media are here developed at length. The more speculative question, as to how far a constitution of the material atom which makes it consist wholly of a system of electrons describing orbits round each other suffices to represent or illustrate the properties of matter, comes under consideration in various respects: this hypothesis in many of its features would agree with the well-known theory of vortex atoms.

The theory of refraction equivalents is developed, leading to Lorentz's results. The theory of optical dispersion is treated from the generalised standpoint that the molecule vibrates about a configuration of steady motion instead of one of rest: it appears, also, that the formula usually given for the square of the refractive index must be replaced by a similar formula for the Lorentz refraction equivalent.

The character of the mechanical forces that are developed in fluid and solid material media by the electric attractions between the polarised molecules of which they are composed, is considered, and expressions are obtained for them. A distinction is here essential between those forces between neighbouring molecules which are compensated locally, and the ones which give rise to transmitted mechanical force which must be compensated by regular mechanical stress in the medium; somewhat in the manner of the corresponding distinction employed by Young and Poisson in the theory of capillarity. It leads, through the negation of the perpetual motion, to the specification of a function which is the *mechanical* or *organised* energy of the material medium: this is different from the *available* or *free* energy of thermodynamics, which is also represented by an analytical function on account of the negation of the unlimited availability of diffuse thermal energy: it is, of course, also different from the *total* or *aggregate* energy of the molecules of the medium, about which little can be known in detail. The theory of osmotic forces is formulated in relation to the available energy with which they are connected, as they are related to the individual molecules sifted by porous partitions and not to the element of matter in bulk: the known general laws of chemical equilibrium are formulated as corollaries to the same principle. On the other hand, the mechanical forces in a fluid molecular medium polarised in any manner are expressed in terms of the distribution of *mechanical* energy of polarisation. The doctrine of *energetics* (including the conception of temperature), which forms a sufficient basis for the descriptive explanation of the mechanics of statical or steady material systems, thus reposes on the negation of the two types of perpetual motion above mentioned, and therefore ultimately on the discrete constitution of matter.

A thermodynamic application which possesses interest, both from the light it throws on the nature of magnetism and from the circumstances that in it the heat supply is calculated indirectly from the magnetic energy that runs down, is the relation between magnetic susceptibility and temperature in substances not in the very susceptible or ferromagnetic condition. According to the Weberian theory, which fits in with the present view, diamagnetic energy which is not compensated mechanically goes to the induction of Amperean currents in the molecules; while paramagnetic energy not thus compensated goes to orientating the molecules, and thus into heat. It follows that the diamagnetic coefficient is independent of temperature: on the other hand, it is shown that the paramagnetic coefficient should vary inversely as the absolute temperature. These laws were discovered experimentally by Curie, who finds from a very extensive investigation that they have the same order of accuracy at sufficiently high temperatures as the ordinary gaseous laws: at lower temperatures and in ferromagnetic substances the control of the polarised molecules arises in appreciable part from the magnetic interaction of their neighbours, thus vitiating the law as well as introducing effects of hysteresis. The well-known model of Ewing would thus represent an ideal perfect ferromagnetic in which the control arises wholly from the latter cause.

In application of the previous results as to how far physical actions can be considered as transmitted across the æther by elastic stress, the conditions are formulated under which the

correlative principle utilised by Poynting is valid, that the actual rate of change with time of the organised or mechanical energy within any region is expressible explicitly as a surface-integral over its boundary.

The mechanical effects of light-waves are reconsidered in the light of this molecular theory. The conclusion is reached that such effects are wholly associated with absorption of the radiation, that no influence of perfectly transparent media on radiation can provoke a mechanical reaction. There is a mechanical force acting on an absorbing mass, in the direction of the incident radiation and equal to $E(1 - m^{-2})$, where E is the energy absorbed per unit time and m is the real part of the index of refraction. Partial analogies are furnished by the mechanical effects of Hertzian radiation on a medium built up of conducting linear circuits, and of sound waves on a medium formed of a system of resonators.

As an application of the law of the mechanical forcive on dielectrics, the changes of dimensions of a condenser under electrification are considered. The problem is found to admit of exact solution if the condenser layer consists of a closed sheet, of any form, but of uniform thickness. In that case the mechanical stress in the material of the sheet proves to be simply of the type of the Faraday-Maxwell stress. The theory is compared with Quincke's experimental results: their main features are verified, including those which led Quincke to assign a wholly non-mechanical origin to the effect: but something less than half the change of volume remains over as an intrinsic electric deformation, not due to the transmitted mechanical forces.

Finally a series of practical illustrations of the mechanical theory are treated, some of which have already been employed for experimental measurement, and which are capable of still further application. The mechanical circumstances attending the refraction of uniform fields of electric force by fluid media are developed. The theory of various arrangements for measuring electric tractions and pressures in fluid dielectrics is worked out. The effect of an electric field on the velocity of ripples on the surface of a conducting or a dielectric fluid is determined: as also are the relations of electric polarisation to vapour tension and fluid equilibrium. The internal mechanical forces in a complete magnetic circuit are examined, and also the traction between the interfaces when it is divided: and the mode of calculation of the stress in a sphere of iron in a uniform magnetic field is indicated, agreeing for this case with Kirchhoff. The mutual influence of stress and magnetisation is analysed, with reference to the experimental investigations of Bidwell.

June 3.—"Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races." By Miss Alice Lee, Bedford College, and Karl Pearson, University College. Received April 9.

The numerical constants of this paper were calculated in the hope of reaching some general ideas on comparative variation and comparative correlation in the case of civilised and uncivilised races, and further of determining, if possible, any general law connecting relative sexual variation and relative sexual correlation with the degree of civilisation, and so, with what is probably inversely proportional to the degree of civilisation, namely, the intensity of natural selection.

The following two principles seem to flow from a study of variation in the organs of man:—[1]

(*a*) Civilised man is more variable than uncivilised man.

(*b*) There is a greater equality of variation for the two sexes in uncivilised than in civilised races. Civilised woman appears, on the whole, to be slightly more variable than civilised man.

Both these principles are in accordance with the intensity of the struggle for existence—and the amount, consequently, of natural selection—being greater for uncivilised than for civilised races, and, further, greater for men than for women in the latter races.

The problem of correlation is, however, of a less simple character. While the action of selection can be shown theoretically to reduce variation, it by no means follows that it reduces correlation. Indeed, selection may increase, decrease, or reverse correlation at the very same time as it is reducing variation. We have then the following problems to guide us in the treatment of actual statistics:—

[1] See "Variation in Man and Woman," by K. Pearson: "The Chances of Death," vol. i. pp. 256–377, where some 155 cases of human variation for both sexes are dealt with.

(*a*) Is correlation more intense among civilised than among uncivilised races?

(*b*) How does the relative correlation of the sexes differ in civilised and uncivilised races?

(*c*) Is there any marked prepotency of either sex in the matter of correlation?

These are the problems which the present calculations were designed, not to definitely solve, but to illustrate.

Unfortunately, adequate measurements on living members of uncivilised races are not very numerous, nor for the purposes of correlation generally very satisfactory. Reasons are given in the paper why long bones form more suitable material than skulls, and the measurements made in France by Rollet, and on the Ainos in Japan by Koganei, are discussed at length.

The following results are suggested by a discussion of the measurements.

(1) Civilised man has progressed as a rule on primitive man in size, variation, and correlation.

(2) This progression can hardly be accounted for by increased selection (because of the increased variation), not by decreased selection (because it is inconsistent with the relative changes in male and female size). It might possibly be accounted for by decreased selection and improved physical conditions.

(3) Woman is more variable than man in civilised races.

(4) Woman is more highly correlated than man in civilised races.

(5) In uncivilised races the sexes are more nearly equal in the matter of size, variation, and correlation than in the case of civilised races.

(6) It is impossible to say that civilised woman is nearer to the primitive type than civilised man. While civilised man differs more from the primitive type than civilised woman, so far, probably, as absolute size is concerned, he has made only about half her progress in variation, and hardly any progress at all in correlation.

(7) The causes (*e g.*, lessening of selection) which tend to increase variation may also increase correlation. In other words, the intensity of the struggle for existence is not necessarily a measure of the intensity of correlation.

Mathematical Society, June 10.—Prof. Elliott, F.R.S., President, in the chair, and subsequently Major MacMahon, R.A., F.R.S., Vice-President.—Mr. W. W. Taylor gave, in some detail, a description of several models of the regular convex and star solids.—The following papers were communicated:—The calculus of equivalent statements (sixth paper), by H. MacColl; on the primitive substitution groups of degree fifteen, by Dr. G. A Miller; and a generalised form of the binomial theorem, by Rev. F. H. Jackson.

EDINBURGH.

Royal Society, June 7.—Prof. Geikie, F.R.S., in the chair. —Sir William Turner read a paper by Dr. Broom, South Africa, on the comparative anatomy of the mammalian organ of Jacobson.—Prof. C. G. Knott gave the concluding paper of the series on magnetic strains, for which the Council has awarded him the Keith Prize for 1893–95. His results may be summarised thus:—All the iron and steel tubes follow approximately the same law as regards their longitudinal dilatation in a longitudinal magnetic field. In moderate fields the dilatation is positive; but it is negative in higher fields. The maximum occurs in field 150 ± 50, according to the thickness of the walls —the thinner the wall, the lower the field corresponding to the maximum dilatation. The great diversity in the volume-changes within the cores shows that the transverse dilatations must be of such a value as to be in some cases less than half the longitudinal dilatation, sometimes greater. This is particularly true of the steel tubes. The behaviour of nickel is much simpler than that of iron. On the whole, the cubical dilatation is determined by the longitudinal dilatation, both being negative and more nearly alike in order of magnitude than in the case of iron. Excepting for the tubes of narrowest bore, the transverse dilatation is positive, and about ¼th or ⅓th of the longitudinal dilatation. The change of volume of a mass of nickel turnings enclosed in a brass tube and placed in the magnetic field is much smaller than the volume-changes in the bores of the tubes. The cubical dilatation is always positive, and increases steadily from $1 \cdot 56 \times 10^{-8}$ in field 107, to $27 \cdot 4 \times 10^{-8}$ in field 570.—In a paper on the solution of equations connecting linear vector functions, Prof. Tait derived a general proposition regarding the commutativeness of strains, and noted connected questions.

—On the electrification of air by uranium and its compounds, by Dr. J. C. Beattie. Experiments were described to test the electric state of the air in the neighbourhood of metallic uranium, or of other metals on which a salt of uranium had been deposited, when these were charged to a positive or negative potential. The method adopted was the electric filter method of Kelvin, Maclean, Galt. It was found that the air drawn away from the negative electrode of a Ruhmkorff inductorium, or from the kathode of a Crookes' tube, or from the wire joining the negative electrode of the coil to the kathode of the tube, was always negatively electrified. On the other hand, the air drawn from the neighbourhood of the positive electrode of the coil, or from the anode of a Crookes' tube, or from the wire joining them, was found to be positively electrified. This positive electrification of the air was always less than the negative corresponding. With uranium insulated in a metal cylinder and connected to the terminal of a battery, while the cylinder and the other terminal were connected to the case of a quadrant electrometer, the air was electrified positively when the uranium was electrified positively, and negatively when the uranium was electrified negatively. With the metal cylinder insulated and joined to one terminal of the battery, while the uranium still inside the cylinder and the other battery terminal were connected to the electrometer case, it was found that the air was negatively electrified when the cylinder was positively electrified, and *vice versâ*. The negative electrification of the air was always less than the corresponding positive electrification. Both attained a maximum value when the difference of potential was between 10 and 20 volts per cm. of air space. The same results were obtained when metals were covered with salts of uranium and then charged to positive and negative potentials. Dr. Beattie also read a note on this subject by Lord Kelvin. The following is an abstract of the note:—The effective conductivity induced in the air by the uranium influence is, of course, greatest in the immediate neighbourhood of the uranium, but there is something of it throughout the enclosure. Hence it may be expected that electricity of the same kind as that of the uranium will be deposited in the air close around it, and electricity of the opposite kind in the air near the enclosing metal surface. And the quantity flowing from either the uranium or from the surrounding metal per sq. cm. of its surface increases but little with increased voltage when this exceeds 5 or 10 volts per sq. cm. Hence, if the dimensions and shapes of the uranium and of the surrounding metallic surface are such, that for small voltage, such as 10 or 20 volts, the electricity lodged in the air by discharge from the uranium preponderates over that discharged from the surrounding metal, the excess must come to a maximum and diminish, may be even down to zero, with greater and greater differences of potential; and at potential differences still greater the electricity lodged in the air from the outer metal may preponderate, and the electricity in the air drawn off and given to the filter be of opposite sign to that of the uranium which was found with the lower voltages. *Provided the configurations are such, and the voltages are so moderate that disruptive discharge does not intervene to any practically disturbing extent.*—On simple formulæ giving approximate values of the roots of the Bessel function of order n and its first derived function, in terms of the roots of (say) $J_2(x) = 0$, $J_3'(x) = 0$, (n even), or those of $J_3(x) = 0$, $J_4'(x) = 0$, (n odd), by Dr. W. Peddie. In this paper were given simple expressions by means of which the roots of $J_n(x) = 0$, $J'_{(n+1)}(x) = 0$ can be obtained when the roots of $J_\rho(x) = 0$, $J'_{(\rho+1)}(x) = 0$ are known ($\rho < n$). These expressions lend themselves readily to numerical calculation, and give values of the roots which become more and more nearly true as x increases. Even for the smaller roots, beyond the first two, the values found are highly approximate when $n - \rho$ is not too great.

Mathematical Society, June 11.—Mr. J. B. Clark, Vice-President, in the chair.—The following papers were read:—On superposition by the aid of dissection (continued), by Mr. R. F. Muirhead; on a method of studying displacement, by Mr. R. F. Muirhead; the isogonic centres of a triangle, by Dr. J. S. Mackay.

DUBLIN.

Royal Dublin Society, March 24.—Prof. E. Percival Wright in the chair.—A paper was presented by Mr. J. E. Duerden, of Kingston, Jamaica, on Jamaican Actiniaria (Part i. Zoantheæ), being communicated through Prof. A. C. Haddon. —Prof. W. J. Sollas, F.R.S., read a paper on an apparatus for submarine observation. Samples of new colours with metallic lustre, mosaics and pavement, lent by the Vitreous Mosaic Co., together with a collection of chemicals made by Harrington Bros. for the glass, china, and enamel industries, and for photography and electro-plating, were described by Prof. W. Noel Hartley, F.R.S.—Prof. E. J. McWeeney gave a demonstration of the bacillus of the bubonic plague.

April 21.—Prof. W. J. Sollas, F.R.S., in the chair.—On the possibility of boring and raising a portion of a coral reef from a great depth, and on an apparatus for demonstrating the folding of rocks due to lateral pressure, by Dr. J. Joly, F.R.S.—The formation of humus, its action in the nitrification of ammonium compounds, by Mr. W. E. Adeney.

May 19.—Prof. W. J. Sollas, F.R.S., in the chair.—Dr. J. Joly, F.R.S., read a paper on the volume change of rocks attending fusion.—Sir Howard Grubb, F.R.S., read some notes on a recent paper by Prof. Hale, of Chicago, respecting the relative merits of reflecting and refracting telescopes, (*a*) when used for visual work, (*b*) when used for photographic work.—Prof. D. J. Cunningham, F.R.S., made some observations on the Cape hunting dogs in the gardens of the Royal Zoological Society, Dublin.

PARIS.

Academy of Sciences, June 14.—M. A. Chatin in the chair.—Experimental verification of the theory of gradually varied flow in open channels, by M. J. Boussinesq.—Fossil forest of *Calamites Suckowii*. Specific identity of *Calamites Suckowii* (Br.), *Cistii* (Br.), *Schatzlarensis* (St.), *foliosus* (Gr.), *Calamocladus parallelinervis* (Gr.), and *Calamostachys vulgaris* (Gr.), by M. Grand 'Eury. In a fossil forest at Treuil, the remains consist almost entirely of *Cal. Suckowii*, of which *Cal. Cistii* formed the part above ground.—Application of the method of Poinsot to non-Euclidian statics, by M. J. Andrade. —Statics and the geometry of Lobatchefsky, by the same.—On the calculation of the resistance of the air to a disc for a velocity of twenty metres per second, by M. P. E. Touche.—On a propelling system for boats, by M. Y. Le Guen. — On the cosmic force curve, by M. Baraduc. — On isometric surfaces, by M. A. Pellet. — On small periodic movements of long-period systems, by M. P. Painlevé. — A mercury interrupter for large Ruhmkorff coils, by MM. E. Ducretet and L. Lejeune. The contact-breaker described, a figure of which is given, possesses the advantages of high speed, and certainty of break, without the danger of the alcohol igniting after long use. It admits of ready adjustment of speed.—On the dynamics of homogeneous chemical reactions, which take place with evolution or absorption of heat, by M. Michel Petrovitch.—Contribution to the history of the iodides of phosphorus, by M. A. Besson. Chemically pure PI_3 has been obtained by the action of dry HI upon PCl_3. It is completely decomposed by water without forming either free iodine or a solid deposit. The solution of PI_3 in carbon bisulphide is completely decolorised when shaken with an excess of mercury. The possible existence of an unstable P_3I_4 is also indicated, the existence of which gives a probable mechanism for the conversion of yellow into red phosphorus by iodine, the equations being $P_3I_4 = P_2I_4 + P$ (red), and $P_2I_4 + P$ (white) $= P_3I_4$.—On a method of oxidation and chlorination, by M. A. Villiers. The presence of a trace of a manganese salt accelerates many oxidations, as, for example, that of oxalic acid by a mixture of hydrochloric and nitric acids. This action is comparable with that of a ferment, and is of importance in vegetable physiology.—Breaking up of the fundamental band of chlorophyll, by M. A. Étard. By reducing the concentration of a carbon bisulphide solution of chlorophyll derived from *Lolium perenne*, the large band 729-635 splits up into three. This method of dilution, together with the superposition of two spectra in the same field, serves to show minute differences existing between chlorophylls derived from various sources.—On the oxidising action of manganous salts and on the chemical constitution of the oxydases, by M. Gab. Bertrand. The salts of manganese act as oxygen carriers to many organic compounds. The results are given of the action of various manganous salts upon hydroquinone in presence of air, and the theory is developed that these salts are partially hydrolysed into free acid and manganous oxide, that the latter takes one atom of oxygen forming MnO_2, and that the organic compound is oxidised by the remaining half molecule of oxygen. —Action of nickel upon ethylene. Synthesis of ethane, by MM.

Paul Sabatier and J. B. Senderens.—On isolauronolic acid, by M. G. Blanc.—Action of acetylene upon silver nitrate, by M. R. Chavastelon. According to the conditions of the experiment, either $C_2Ag_2.AgNO_3$, or C_2Ag_2 is formed.—Determination of resin oil in essence of turpentine, by M. A. Aignan. A portion of the oil is distilled and the rotatory power of the residue measured. It is notably reduced if the oil is adulterated.—On the active principles of some arums, by Mlle. J. Chauliaguet, MM. A. Hébert and F. Heim.—Action of albumoses and peptones in intravascular injections, by M. E. Fiquet.—On the relation of certain layers of lead carbonate to caves and ancient beds of subterranean rivers, by M. De Launay.—The characteristics of Broxburn oil shale, by M. C. E. Bertrand.—Classification and phyllogeny of the Goniatites, by M. Émile Haug.—On the Diceratineæ of the Tithonic beds in the Cevennes, by MM. V. Paquier and F. Roman.—On the Cueva del Drach (Dragon's Cave) in the Island of Majorca, by M. E A. Martel. This cave is in the Miocene limestone, and is the largest known in tertiary strata. It contains a subterranean lake 177 metres long, and from 4 to 9 metres deep.—Action of the X-rays upon the retina, by M. G. Bardet. The rays produce upon the retina a luminous impression which, although very faint, is quite clear.—Remarks by M. d'Arsonval on the preceding paper.—On the constitution of the large sympathetic nerve; its trophic centres, by M. J. P. Morat.—Experiments on the stimulation of nerves by the electric rays, by M. B. Danilewsky.—On a very grave case of dermatitis following two applications of the X-rays, by M. G. Apostoli.—Local therapeutic action of high frequency currents, by M. Oudin.—The saprophytic form of human and fowl tuberculosis, by MM. Bataillon and Terre.—On the influence of the hypnotic sleep upon the gastralgia of the dorsal tubes, by M. Ed. Spalikowski.—On the results of meteorological observations made in Marchuria and in the neighbouring countries, by M. Michel Venukoff.—On the variation of the surface temperature in soils of different natures, by M. Joseph Jaubert.

NEW SOUTH WALES.

Linnean Society, April 28.—Prof. J. T. Wilson, President, in the chair.—On the fertilisation of *Eupomatia laurina*, by Alex. G. Hamilton. Fertilisation appears to be effected by a small Curculio (an undescribed species of *Elleschodes*, specimens of which are now in the hands of the Rev. T. Blackburn for description), myriads of which, attracted by the scent of the newly-opened flowers, crowd the blossoms to the exclusion of other insects. They feed on the staminodes, eating their way into the heart of the flower. Microscopic examination of individual beetles taken at random showed that the antennæ, tarsi and other parts were coated with pollen. Robert Brown conjectured what happened, but did not see the beetles. Dr. Harvey saw the latter, but he appears not to have published any particulars.—Descriptions of the nests and eggs of three species of Australian birds, by Alfred J. North. Descriptions were given of the eggs of *Cracticus rufescens*, De Vis, from the Herbert River, Q.; *Sphenura broadbenti*, McCoy, from the Otway Forest, Victoria; and *Dendrocygna eytoni*, Gould, from the Macquarie River, N.S.W.—On some new or little-known Australian fishes, by J. Douglas Ogilby. Two new genera were characterised, and ten species of fishes were described as new.—On the development of the Port Jackson shark (*Heterodontus Phillipi*), Part I. early stages, by Dr. W. A. Haswell, Challis Professor of Biology, Sydney University. The hope is not unreasonably sanguine that the embryonic development of a type so ancient as *Cestracion* (*Heterodontus*) might exhibit some important primitive features. With regard to the stages now described, however, any expectations of this kind cannot be said to have been fulfilled; and what impresses one most in the results is the extraordinary persistency of certain characteristics which are not known to have any vital significance. There can be little doubt, for example, that the orange spot, which forms such a striking feature of the egg of an Elasmobranch in its early stages, has been handed down with but little change from Palæozoic times.—Description of a new Helix, by C. E. Beddome. The new species is near *H. mossmani*, Brazier, in its markings, but differs in being umbilicated and white-lipped. *Hab.*, Yeppon, near Rockhampton, Q.—Descriptions of new species of Australian Land Planarians: with notes on collecting and preserving, by Thomas Steel. Seven species of *Geoplana* from New South Wales and Queensland were described as new.—Descriptions of new species of Fijian Land Planarians, by Thomas Steel. One species of *Geoplana* and one of *Rhynchodemus* were described as new; and *Bipalium kewense*, Moseley, was recorded as common under logs on the Navua River, Viti Levu. Mr. Steel exhibited a fine collection of well-preserved and displayed Land Planarians, representing the species described in his paper, and illustrating the modes of preservation and the results after the use of the various preservative media advocated therein. Mr. Steel also contributed the following note on *Peripatus*. "I desire to place on record the occurrence in New South Wales of *P. oviparus*, Dendy, the Victorian form of *Peripatus*. While collecting in January of this year, between Exeter and Bundanoon (Moss Vale District), on turning over a log, I noticed a *Peripatus* which, from its attitude and general appearance, specially attracted my attention. This proved to be a female specimen of the above species, and, so far as I am aware, this is the first occasion on which its occurrence in this colony has been definitely recorded. The lozenge-shaped pattern which characterises most of the specimens found in Victoria is well displayed; and the fact of the ovipositor being fully extruded in the specimen, which I now exhibit, is sufficient guarantee of its identity. When visiting the Australian Museum a few days ago, I had an opportunity of examining the specimens of *Peripatus* preserved there, and I was interested in noticing that those collected by Mr. Helms, in 1889, at Mount Kosciusko belong to the same species. All of the females in the Museum collection from that locality, which I examined, have the ovipositor plainly visible, and in many of them it is fully extruded."

CONTENTS.

THURSDAY, JULY 1, 1897.

LAKES RUDOLF AND STEFANIE.

Through Unknown African Countries. The First Expedition from Somaliland to Lake Lamu. By A. Donaldson Smith, M.D., F.R.G.S., Hon. Member of Acad. Nat. Sci., Phil. Pp. xvi + 471, with illustrations and five-sheet map. (London: E. Arnold, 1897.)

THE region of Africa to the south of Eastern Abyssinia has been long regarded as of exceptional interest, both by the naturalist and the novelist. So early as 1847, when most geographers still believed that the snows of Kilima Njaro were a traveller's tale, and before Kenya had been seen by a European, Captain Short returned from the Juba, and asserted the existence of snow clad mountains away to the westward. According to the statements of some native traders to the court of Abyssinia, the bamboo forests of the same region were inhabited by tribes of dwarfs; and these reports were published by Captain Harris in 1844, long before the measurements by Schweinfurth, the skeletons sent home by Emin, and the discoveries of Stanley had called prominent attention to the pigmy races of Equatorial Africa. At a subsequent period, the late M. Abbadie placed a great mountain in the same unvisited district, exaggerating its height, as he recently naïvely remarked, in the hope of calling attention to it. Suahili traders also reported the existence in this region of two great lakes, of which the larger was sometimes called Samburu, and at others was confused with Baringo; it was the hope of reaching this lake region that led to the expedition of Burton and Speke, which came to such a disastrous end at the landing-place near Berbera. The excitability of the Somali, and the fascination of the discoveries made in East Africa south of the equator, subsequently diverted attention from this region, and it was not until 1888 that the first Europeans reached it. Teleki and Höhnel then entered from the south, and found, as reported, that there were two great lakes: the larger was named by its discoverer Lake Rudolf, apparently on the principle of Oliver St. John's dedication of his memoirs to Cromwell, who, by persuading him to travel, had given him the leisure in which to write them. After Teleki's return, several attempts were made to reach the twin lakes from the north, along Burton's projected route. But it was not until 1895 that success was gained by the expedition described in this volume.

The author, Arthur Donaldson Smith, is a young American doctor who prefers sport to surgery. He made a preliminary excursion in Somaliland in 1893, in order to gain experience of the people and the conditions of travel. Having further prepared himself by a course of training in geographical surveying, under Mr. Coles, he returned to Berbera in June 1894. He was accompanied by two English companions—a young sportsman, Mr. F. Gillett, and an experienced taxidermist and collector, Mr. Dodson; both of them gave him most loyal assistance. A force of 82 Somali were enlisted, and 84 camels purchased. The expedition started from Berbera on July 15; Dr. Smith had the advantage of the help of the most famous of African caravan headmen, the late Dualla Idris, who is, however, referred to as Haji Idris. The expedition crossed Somaliland to Milmil, and thence struck westward, and somewhat southward, in the hope of traversing the countries of the Arussa and Janjam to Lake Rudolf. The Webi Shebeli was crossed on September 1, and its course followed to a Galla settlement round the remarkable tomb of Sheik Hussein (the Scech Uscen of Bottego). The native tradition as to the origin of this building is clearly a legend, and more information about it would have been welcome. While staying here, Dr. Smith heard that the Abyssinians were in force at Ginea, a town a little distance to the south Mr. Gillett went to ask the chief for permission to proceed; but after considerable negotiations, during which the Abyssinians were friendly, the permission was refused, and the expedition had to return to the Shebeli. It descended this river to Bari, the village reached by the brothers James and Lort-Phillips in the first crossing of Somaliland. Thence the persevering explorer again turned westward, crossed the Juba, and marched over the Borana Galla country to Lake Stefanie. After exploring this lake, and the district to the north, the expedition continued westward to Lake Rudolf. Dr. Smith followed the course of the river that flows into the northern end of the lake for 75 miles. The river was apparently about to turn to the north-east, but he could follow it no further; and thus it is still uncertain whether the Nianam is the lower part of the Omo. From Lake Rudolf the expedition marched southward, across the waterless wastes of the Rendile country to the Nyiro, and descended the valley of the Tana to the coast.

The narrative of the journey is of great interest throughout. It abounds in sporting adventures, which are tersely and vividly told. The author had narrow escapes from elephants, rhinoceros, and lions. He came into conflict with hostile tribes on one or two occasions; but it was apparently not his fault. African natives are often fools, and it is impossible to read the narrative without feeling that there was nothing the author wanted more than peace. He had diplomatic intercourse with many "kings" and one "emperor," and throughout all his varied experiences he showed himself a man of resource, of courage, and of indomitable perseverance.

The scientific results of the expedition were very important. The five-sheet map, based on an extensive series of astronomical observations, is very valuable. The zoological collections were rich, especially in vertebrates; they are described in a series of appendices by Dr. Günther, Mr. R. I. Pocock, Prof. Jordan, and others, whose names might well have been given in the list of contents as well as the titles of their contributions. The collection of birds was, however, the most important, though there is no report upon it, and there is no complete reference to Dr. Sharpe's paper in which it was described. The general value of the zoological collection lies in the fact that it comes from the unexplored area between southern Somaliland and northern British East Africa. Many of the separate observations are also of interest. The author describes an attack made on a lion by some hyenas; he notes the existence of a large rhinoceros differing from the common species in the shape of the front part of the head. This animal has been recorded twice previously, but it is apparently still represented in Europe by a single horn.

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The principal geological problem, which it was hoped the expedition would settle, was whether the Omo Valley is a continuation of the great East African Rift Valley, in which Lake Rudolf lies. Unfortunately the circumstances which prevented Dr. Smith tracking the Nianam further towards its source are responsible for this question being left open. Dr. Smith, however, believes that the Omo is one of the head streams of the Juba, and does not flow into Lake Rudolf, as is generally believed from Borelli's work. If the altitudes given us are correct, the new view is impossible. Borelli descended the Omo to the level of 3450 feet: Bottego ascended the Juba to a height of over 4500 feet: the Omo cannot flow 1000 feet up hill into the Juba. Another alternative was once possible. We have previously suggested, from Dr. Smith's preliminary map, that "it is just possible that the Omo reaches this lake [Abaya] instead of Basso Narok [*i.e.*, Lake Rudolf]" [Gregory, "Great Rift Valley," p. 258]; but now Dr. Smith fixes the height of Lake Abaya as 3460 feet, so that the Omo is excluded from that goal. Hence, we are driven to the conclusion that the Omo must continue as the Nianam, and flow into Lake Rudolf, as Borelli believed; this conclusion is in agreement with the altitudes and with the trend of the country as shown by Dr. Smith's map.

Another point of interest to geologists is the evidence as to the existence of volcanic activity in this region; for Dr. Smith tells us that the Teleki volcano at the southern end of Lake Rudolf, in August 1895 "sent up clouds of smoke, and at night a great stream of glowing lava could be seen pouring from one of the craters" (p. 333). This information is especially interesting, as Mr. Neumann found no signs of activity there, and as the oft-asserted "Volcano Doenyo Ngai" now turns out not to be a true volcano.

In one respect Dr. Smith's information is strikingly different from that of Teleki and Höhnel. These explorers found the water of Lake Rudolf so brackish that they could hardly drink it, while that of Lake Stefanie was so salt that it was quite useless, and they could only stay on its shore owing to the existence of pools of rain-water. This was in 1888. But in 1895 Dr. Smith found the water of both lakes was quite fresh, in which he is confirmed by a very accurate observer, Mr. A. H. Neumann, for the northern end of Lake Rudolf. There can be no doubt that a remarkable change in the salinity of these lakes has taken place in only seven years; and the possibility of such changes must be borne in mind in considering the origin and relations of the African lake faunas. For example, it has been urged that the marine origin of the Tanganyika fauna is impossible, since there is no trace of marine influence in that of Lake Nyasa, through which the former, on the usual theory, must have passed. But Lake Stefanie reminds us that either a too rapid freshening of a lake, or a period of intense salinity, may obliterate the original fauna. Hence the complete absence of any marine types from the fauna of Nyasa is no proof that that of Tanganyika had not a marine origin. It should, however, be remarked that we are not expressing any acceptance of the view that the fauna of Tanganyika has any marine characters; but only that one of the arguments against that view is invalid.

The part of the book most open to criticism is that dealing with ethnography; but the facts mentioned show that the country traversed is of extreme interest. The author found some dwarf people about five feet high, and gives us a list of their words, although a few phrases would have been more useful; he describes some wells, which he attributes to the ancient Egyptians: and he met with Midgans, Tomal and "half-caste Boran," respecting each of which more detailed information is desirable. One quaint slip in this department is speaking of a "tamasho (*sic*) or equestrian exhibition" as though it were a Somali word instead of Hindustani for a "function." But one man cannot do everything; and now that the author has shown the way, we hope that other travellers will follow and collect further information regarding the many questions which the volume raises. For it is a great testimony to the interest of the country that Dr. Donaldson Smith's valuable book suggests as many problems as it solves.

J. W. G.

EXERCISES IN PHYSICS.

Problems and Questions in Physics. By C. P. Matthews and J. Shearer. Pp. vii + 247. (London: Macmillan and Co., Ltd., 1897.)

THIS useful book contains more than thirteen hundred problems in the various branches of physics, and, from the point of view of degree work, covers the ground required for the London Matriculation and Intermediate Science Examinations, as well as part of that for the Final B.Sc. It is, however, intended for all students of elementary physics, including, therefore, students of engineering, and the peculiar needs of the latter have also been provided for.

The authors begin with an introduction, which, as they explain, is intended not only to be read, but continually referred to, and contains short sections on physical measurement in general, units, vectors, the expression of physical relations by curves, averages, and approximations. A few examples are added on graphic methods, as well as a list of units and physical constants for use in the problems. Next follow the problems themselves; and the book ends with a set of four-figure mathematical tables, the solutions to the problems, and a rather meagre index.

In a work designed for students of both engineering and physics, one naturally looks first to see what is said on the vexed question of the unit of force. We congratulate the authors on the line they have here taken. As they explain in their preface,

"Many of the students who will use these problems are pursuing engineering courses. In such case, they must of necessity use engineering units. The aim has been not so much to train them in the use of these units—an abundance of this training comes to them during their course—but to bring out the relation of the so-called practical and gravitational units to the C.G.S. units of physics."

The C.G.S. and foot-pound-second systems are first defined, and the superfluous character of the latter tacitly assumed. This is shown by the fact that, after its definition has been given, the word poundal does not again occur. The authors then explain that pound and kilogramme are used by engineers as names for units of

force, and the two corresponding gravitational systems are well illustrated by problems introduced, throughout the mechanics section, among those on C.G.S. measurements.

This takes us as far as is at present, perhaps, possible in the direction of a compromise to which many teachers of physics are now looking forward—the recognition, namely, of two distinct systems of measurements only; one the C.G.S. with its derived practical system, for scientific and electrical purposes, the other the system used by engineers, and based on the units of length, time, and *force*.

Among other noteworthy features is a good set of problems on dynamos and alternating currents, another on wave and harmonic motions in connection with sound, and a third on gravitational potential in the section on work and energy. Less commendable, however, is the reference to water-levels in connection with electrical potentials. The most perfect "water analogy," and the one which, in our experience, appeals most directly to students, is that in which conductors are represented by water-filled cavities in a large block of india-rubber; it affords, indeed, almost the only means of enabling the average beginner to realise how the potential of a body or of a point in space may be altered by altering the charge on another body at a distance.

It is a pity that those problems which admit of solutions are not all supplied with them. Many are of the nature of examination questions, requiring long answers in words, and to these, naturally, no answers are given; but of the rest, not more than about three-fourths are solved.

We have noticed the following slips. The answers to Nos. 251, 759, 775, 776, 837 are either wholly or partially wrong; in No. 607 the water-worth of the dish should be given; and the headings to pp. 204 and 221 want altering. These are, however, small blemishes on an otherwise very useful work. A. P. C.

COSMIC ETHICS.

Cosmic Ethics; or, the Mathematical Theory of Evolution. By W. Cave Thomas. Pp. xxii + 296. (London: Smith, Elder, and Co., 1896.)

IN styling his book "Cosmic Ethics," Mr. Cave Thomas means to imply that not only in morals as a department of "the wider hygiene," but throughout the universe, there is but one law of rightness, that of balance, proportion, or the mean. By "mathematical evolution" he desires to signify that evolution is "the becoming of the proportioned," its goal being "the at-mean-ment of nature."

Starting from the admitted applicability of the idea of quantity throughout the concrete world, and from the progress which the sciences undoubtedly make when measurement or quantitative formulæ can be used in them, Mr. Thomas advances to an apotheosis of the average, and offers principia of the science of proportion and applications of quantification throughout the whole range of human knowledge. By somewhat elementary numerical formulæ we can determine the beau-idéal in the arts, attain to a quantitative ethic, discover that a man ought to drink neither too much nor too little, that his morning tub should not vary much in temperature from that of the human body, that the combination of great athletic and great intellectual effort leads to a break-down, and that technical and specialist education is inferior to general education.

Of the principia we may quote as an instance: "*The mean of fraction* is $\frac{1}{3}$; it is the fraction which is equally indifferent to the two extreme fractional limits of $\frac{1}{1}$ and $\frac{1}{0}$." (!) Of the exemplifications of the formulæ, we may point out that they are purely arbitrary. We ought to aim, we are told, at not diverging from the average, which is the ideal, to any extent which carries us beyond the middle third of our scale. Why not the middle fifth or seventh? There is no attempt to point out how the qualitative kind to which any particular scale is applicable is determined, and this despite of the fact that in a quotation which he makes from Reynolds—one of a constantly recurring set of quotations—that point is definitely raised.

Mr. Thomas accepts the Darwinian theory, though how the importance which that theory ascribes to "accidental variations" from type, can be reconciled with his own views as they stand, it is difficult to see. In fact, as they are here put before the reader, Mr. Thomas's doctrines will not allow of being harmonised into an intelligible system. This is the more to be regretted, as there is no doubt that an adequate elucidation of the theory of quantity, number, and measurement, would be of very great service to applied science. Nay, it is perhaps not too much to say that from the Galton system of composite photography, and from the statistical results of anthropometry, to which the author refers, conclusions of considerable value for art may be drawn. But they are not those drawn by Mr. Cave Thomas, nor to be drawn by his methods; though his considerable judgment in art and his grasp of the distinction between the organic fitness of an object for its purpose and its appositeness to human taste, make this department of his investigations the least unpromising.

His quotation of the headings of the chapters in Aristotle suggests the suspicion that Mr. Thomas has not studied that author in the Greek. Otherwise the attribution to him of a system of quantitative ethics would be, despite of the great authorities for that view, less pardonable than it is. Yet to the Greeks Mr. Thomas has chosen to go in his quasi-Pythagorean glorification of quantity. H. W. B.

OUR BOOK SHELF.

The Flora of the Alps. By Alfred W. Bennett, M.A., B.Sc., F.L.S. 2 vols., with 120 coloured plates. Pp. xxii + 165; vi + 223. (London: J. C. Nimmo, 1896.)

THE Alpine wanderer will not be very grateful to Mr. Bennett and his publishers for this new "Flora of the Alps." The net is spread widely; for, in addition to the whole Swiss flora, there are included here plants from adjacent mountain districts, and also the Pyrenees. The result is a rather cumbrous affair, and yet unsatisfying in detail. The species of each genus are enumerated with very short and sometimes rather inadequate characters, so that the identifying of specimens is not always as easy as it might be. That the book is arranged according to the system of Bentham and Hooker we may regard as a welcome innovation in Alpine floras, which have been too long wedded to the irritating Linnæan system. The

paper and printing are in their way admirable, but the thickness of the former does not make for portability. The custom of arranging Latin and English names under separate indices should be prohibited. It is a time-honoured survival in some Floras, but a constant source of annoyance to their users. Whether the 120 coloured plates of Alpine plants scattered through these pages will prove acceptable to purchasers of the work, we cannot say. A very large number of them are to be found in Wooster's "Alpine Plants," published a quarter of a century ago, though we have searched in vain for any indication of this fact. Then, too, some trouble was taken in the printing, and the result was not unpleasing. In Mr. Bennett's "Flora," these old plates have been mutilated, as will be obvious to any one who cares to compare the two works. In these days of modern methods and high-priced books we expect an advance, not a retrogression. We have said sufficient to show that the ideal Alpine Flora still remains to be produced. Our own view is that it should be somewhat on the lines of Hooker's "Student's Flora of the British Islands," with a separate volume of woodcuts similar to those of the well-known "Companion" to Bentham's "Handbook." If coloured plates are wanted, a draftsman of high artistic capacity and requisite botanical knowledge must be employed, whilst the printing must be of the very best. Nor would the public which travels in the Alps, and collects and examines the flowers growing there, be backward in its recognition of such a work.

First Stage Mechanics of Fluids. (The Organised Science Series.) By Prof. G. H. Bryan, Sc.D., F.R.S., and F. Rosenberg, M.A. Pp. vi + 208. (London: W. B. Clive, 1897.)

IN the pages of this book the authors have brought material together to cover that part of the subject of mechanics which is required by the Science and Art Department in the elementary examination. There are also chapters devoted to that portion of dynamics which is required by the corresponding syllabus in the mechanics of solids. The twenty-three chapters which fulfil the above-mentioned requirements are so arranged as to form an excellent elementary treatise, and also a good introduction to those who wish to make a further study of the subject. The style of treatment is similar to that adopted in other books of this series. The authors advocate strongly the importance of each student working out examples by himself, and with this idea have inserted numerous solved and unsolved problems. They have also kept down the number of formulæ, in order that the reader shall attack problems from first principles, and not trust to his memory; for those formulæ which have been inserted, proofs have been added. Numerous typical illustrations and figures are inserted in the text, thus rendering it still more serviceable to the young beginner.

Illustrative Cloud Forms. By C. D. Sigsbee. (Washington: U.S. Hydrographic Office, 1897.)

IN this book we have a collection of coloured plates, sixteen in number, illustrative of the different typical forms which clouds assume under various conditions. The classification, nomenclature, and descriptive text are derived from the "International Cloud Atlas" (Paris, 1896), but the plates are from the original paintings made for the Hydrographic Office by Mr. Rudolf Cronau. In addition to the ten standard types which are included in the classification, six further plates are devoted to illustrating certain modifications of these, such as fracto-stratus, fracto-cumulus, mamato-cumulus, &c. Each plate embraces the horizon and sufficient extension of view, so that the observer can obtain a good idea of cloud perspective. The paintings themselves have been made as accurately and as true to nature as possible, and photographs, printed exemplars, together with the artist's personal observations and knowledge of clouds, have all been brought to bear on them. Great pains have been taken by the Hydrographic Office to ensure a faithful reproduction of the originals, and we can safely say that the observer has here before him a most excellent guide for the classification of clouds, which branch of meteorology is becoming every year of more importance as a means of forecasting the weather.

Among British Birds in their Nesting Haunts, illustrated by the Camera. By Oswin A. J. Lee. Part iv. (Edinburgh: David Douglas.)

THE first three parts of this work were noticed in these pages a few weeks ago (May 13, p. 26); the photographic reproductions in the present part are as attractive as those which preceded them, and will interest every student of bird life. There are ten large plates showing the nests of the Woodcock, Oyster-catcher (two plates), Tree Pipit, Reed Bunting, Ringed Plover (two plates), Little Tern (two plates), and Jackdaw. Brief notes upon the birds and their nesting haunts accompany each plate.

More brilliant photographic pictures of the nests of birds have never been published than those which now bear testimony to Mr. Lee's skill with the camera. The work in which the pictures appear is already known to most ornithologists, and it will long receive a full measure of admiration.

The Indigenous Drugs of India; Short Descriptive Notices of the Principal Medicinal Products met with in British India. By Kanny Lall Dey, Rai Bahadur, C.I.E. Second edition. Pp. 387. (Calcutta: Thacker, Spink, and Co.)

A WORK like the present, which is intended to promote the extension of our knowledge of Indian drugs, is much to be welcomed. Indian Materia Medica presents a wide field of research for the botanist, chemist, and pharmacologist. Dr. Lall Dey's book is a useful epitome of the characters and uses of Indian indigenous drugs, and contains a great deal of valuable information. It will form an excellent introduction to larger works on the subject, such as Dymock's "Pharmacographia Indica," and Watt's well-known Dictionary.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Storm in Essex on June 24.

I AM doubtful if an English thunderstorm has ever assumed the proportions that one reached here on Thursday last. Although there is nothing new under the sun, yet there is a good deal new to each individual, and the following facts were not looked on as possibilities by me before I witnessed them on that day.

The 24th was an intensely hot day, and after much distant thunder the storm broke on us about 2.45 p.m. (while haymaking was in full swing) from the north-west. After about ten minutes of the heaviest rain, hail began to fall, and soon a terrific hurricane, accompanied by hailstones larger than hens' eggs (mixed in with others of all sizes downwards), came on and lasted for five minutes, during which most of the damage was done. After this the storm gradually abated, and in something over half-an-hour had passed away. The scene was quite unique and winter-like. The ground was quite white, and in many places the hail had drifted to a foot deep, and every ditch and depression in the ground was full of water and hail. Every

window on the north-west sides of the houses and cottages was destitute of glass—not merely broken, but the whole driven through. Two greenhouses were completely smashed, only one pane in some miraculous way having escaped on the windward side. A bird-cage hanging in a window was demolished, and the bird found in a chair on its back under a bit of glass. Rooks and pigeons were lying about the fields dead and dying, and one of my men secured enough for a rook pie next day. Also we picked up next day some half-dozen small birds while turning over about eight acres of hay.

A stable roof covered by pantiles half-an-inch thick had half the tiles broken into quite small pieces, and has the appearance of having been shot at by rifles. Several chimney stacks had been blown on to the roofs, and in one case close by, through the house to the ground. All the farm buildings and cottages were unroofed more or less.

Trees had fallen in quantity, either torn up by the roots or broken off in the middle. Branches had been twisted off everywhere and hardly a leaf remained; the neighbouring common was beaten down as if an army had stampeded over it.

The crops presented a curious and melancholy sight. The grass intended for hay looked as if a steam-roller had been over it. The oats had also been not only beaten flat, but broken off short, and reduced to a sort of long chaff; in some cases the ends of a piece of stem stuck up, while the middle had been driven into the ground by a hailstone.

The mown ground and the lawn were indented to the depth of from one to two inches all over, much as if a flock of sheep had passed over them. This was, of course, also seen on the flower-beds and mangold-fields. This last crop has also been destroyed to the extent of two-thirds, every leaf broken off, and often the root in two pieces.

A hedge at right angles to the storm and some wall fruit were completely stripped of leaves and twigs, and left with "bare poles" nearly half denuded of bark; not a vegetable remains in the garden. Luckily the area of greatest severity was very small and not in the centre of the storm. The advancing front of the worst part seems to have been only about a mile in width, and to have spent its greatest energy after advancing a like distance.

The hailstones were in appearance a conglomerate of smaller ones cemented together with ice, and generally the centre stone was bigger than the others. They were much collected together in corners, and one was measured, twenty-four hours after the storm, four and a half inches round. SHEFFIELD NEAVE.

Ingatestone, June 28.

On Mimicry.

DR. JORDAN'S suggestion (p. 153) that the result of a one-sided selection involves a physiological one-sidedness unfitting a mimetic species in other respects for the struggle for existence, can hold good only if the selective change in external imaginal characters be correlated with an unfavourable modification of other characters, perhaps in another stage of the insect's life; inasmuch as destruction can modify a species solely in respect to the constants for which it is selective.

Unless such correlation can be shown to exist, the physiological one-sidedness postulated by Dr. Jordan remains as hypothetical as are still many of the axioms on which the existing theories of mimicry are supported.

His objection is precisely analogous with another which is sometimes advanced: that the process of selection towards mimetic resemblance of the imago is rendered nugatory by means of the enormous destruction of individuals in the early stages, and the consequent survival of a very small percentage to hand on the greatly diluted effects of selection. But if the imagos of a mimetic species are distributed about a mean in respect of the degrees of likeness to a model, it is clear that no amount of unselective destruction, *i.e.* one which reduces the numbers uniformly on each side of the mean, can modify the curve of distribution.

That is, no loss of larvæ or pupæ can lessen the force of imaginal selection, unless there be correlation of characters.

Dr. Jordan's suggestion, however, is complementary to one at which I have arrived, but which I have hitherto put forward only privately. Even if there be no correlation of characters, as he assumes, a limitation upon the numbers of a mimetic species may yet be due to interrelation between its abundance and the natural checks upon its multiplication.

If a species, hitherto non-mimetic and persisting in small but constant numbers, come under the influence of a "protected" model, and the distribution of mimetic forms shows that such a phenomenon has probably been common, it must escape destruction in the imago stage in proportion to the degree of resemblance thereby acquired.

If the natural checks on its earlier stages remain constant in ratio, the mimic must become increasingly numerous concomitantly with increase of likeness to the model, the effect on which, though important, need not now be discussed.

But it is possible that, apart from any physiological modifications, the greater abundance of the imago is counteracted by increased destruction in other stages. While the effect of climate, for example, is presumably constant in ratio whether the species be few or numerous in examples, it is almost certain that within limits such important checks as animal parasites (Ichneumonidæ, &c.) become actually more efficient with multiplication of the host. In other words the number, say, of larvæ which can exist in a given area may be limited by such outside causes; so that no amount of lessened destruction of the imago can cause the species to become more numerous, because it is counterbalanced by greater larval destruction. And if the species has a greater chance of survival in the imago stage, it may actually become rarer therein as a result of the necessity that the number of larvæ shall remain constant.

If this be the case, mimicry may indeed be the outcome of natural selection; but, as Dr. Jordan suggests, it may have nothing to do with utility or the survival of the species.

And this leads to a further generalisation: it is conceivable, and indeed probable, that many species can exist indefinitely in small but constant numbers, as rarities, that is, which are unable by the assumption of any favourable modifications to become permanently common, owing to the interrelation of the factors which impose a limit on their multiplication.

June 19. WALTER F. H. BLANDFORD.

A Bacterium living in Strong Spirit.

IT is well known that the shipments of rum from Demerara, especially during the past year, have been "faulty," and very great pecuniary loss has resulted to the colony. Through the kindness of a friend and the courtesy of the Excise authorities, we received certain samples direct from a bonded warehouse; we were informed that the spirit had been returned at 42 per cent over proof, equivalent to 74·6 per cent. alcohol by weight; our determinations showed the assessment to be correct. On microscopical examination of a sediment at the bottom of the samples, using a magnification of 1200 diameters, we found chains of small cocci; after the spirit had been kept for some days the cocci were seen to be surrounded with a gelatinous envelope, and after a further interval of time the cocci were found disseminated throughout the liquid, and were rapidly developing and multiplying. The micro-organism, adopting the classification of Zopf, belongs to the group Coccaceæ, and for the present, from our study of cultivations, we are inclined to regard it as a new species; we have already obtained several stages of its life-history, and hope shortly to be in a position to publish a fuller account of its development and the chemical changes which it produces. Meanwhile, the observation of the existence and multiplication of any micro-organism in a spirit of such alcoholic strength appears to be of so much scientific interest, and the problem of its presence of such technical importance, that we send this note as a preliminary communication.

Oxford, June 23. V. H. VELEY.
LILIAN J. VELEY.

A Well-known Text-Book of Chemistry.

YOU have thought proper to admit to your columns a long and rambling notice of my "Manual of Chemistry," by Mr. M. M. Pattison Muir. It is difficult to make out from this what, definitely, is the charge which the writer brings against the book, but the article winds up with the statement that in his opinion "this book is not a success." I have the satisfaction of believing that chemists will derive little except amusement from this expression of Mr. Muir's opinion; but, as presumably NATURE is read by a portion of the general public and by some scientific persons who may not be acquainted with Mr. Muir's chemical idiosyncrasy, I desire to say, more in the interests of

my publishers than of myself, that this opinion of his is not shared by the writer of any one, so far as I have seen, of the notices which have appeared in other papers.

WILLIAM A. TILDEN.

Royal College of Science, London, June 19.

The Gravitation Constant.

I BEG to point out that at the end of the article on pp. 127–128 of NATURE, relating to my researches on the gravitation constant, there is a misprint. The "oscillation" result for 1892 should be 5·523 instead of 5·520.

The error is not great, but by correcting it a much better concordance appears between the four principal values.

CHARLES BRAUN.

Mariaschein in Bohemia, June 21.

THE AMERICAN EXCAVATIONS IN SOUTHERN BABYLONIA.

FOR the last fifteen or sixteen years we have been glad to watch the endeavours of the Americans to carry out systematic excavations in Southern Babylonia, and we feel sure that all will rejoice with them now that they are able to report a very considerable success. It will be remembered that the first American to visit that country with a view of acquiring antiquities was Mr. Hayes Ward, who went out there early in the "eighties"; and the report which he gave on the matter probably helped forward the later expeditions of Dr. Peters and Mr. Haynes. Dr. Peters and a small party of promising young men went to Baghdad in 1890, and set out from that city for the ruins of Niffer, which are situated a few days' journey to the south-west, where they began to dig. For various reasons, however, Dr. Peters withdrew from the work soon afterwards, and the Committee of Excavations of Pennsylvania University determined to place the undertaking in the hands of Mr. Haynes, then the American Consul at Baghdad. Mr. Haynes took over the work, and for some years past he has devoted all his time to it, through the heats of summer when the land is burnt as hard as a brick, and through the rains of winter and early spring when the plains become seas of mud, has he lived at Niffer, patiently digging through the ruins of the temple, and tower, and ramparts, and court-yard, and hidden chambers of that ancient city. No other excavator has done his work so thoroughly, or so well in consequence, for he never left his post whilst diggings were going on; and though the cuneiform scholar sitting in a comfortable chair at home reading the descriptions of the work by Dr. Hilprecht[1] may think lightly of such devotion to science, it by no means diminishes its value. Moreover, the Arab of the neighbourhood of Niffer is not the gentlest of men; on the contrary, when he is displeased with the "Frangi" excavator, he will break his water-jars, or slit his water-skins as they are passing on donkeys to the river, or try to burn down his tents, or even to kill him, as he has done to more than one excavator.

In the limited space at our disposal we do not intend to describe the details of Mr. Haynes' excavations, but only to call attention to the general results of his work and their bearings upon the early history of civilisation in the East. Like all the cities which lie between the Tigris and Euphrates below Hillah and Baghdad, the mounds of Niffer contain the ruins of a temple of considerable size and of a tower; both rested upon a solid clay platform, the intention of the architect being to lift the buildings which were to be set upon it out of the reach of floods and overflows of the river. Round these ran a wall more than fifty feet in thickness, the object of which was, naturally, to keep out foes from the temple buildings and tower. The ruins which Mr. Haynes found on the platform belong to the temple and tower which a king called Ur-gur built about 2600 B.C.; but below this, Mr. Haynes found another platform which Sargon I. had built some twelve hundred years earlier, for all the bricks bore the name of this king and of his son Naram-Sin. Digging down deeper, Mr. Haynes found the ruins of one or more temples, but there are no inscriptions or marks upon any object which will help us to date them. Elsewhere in the outlying buildings in the mound small but strongly built chambers were found, and it is thought that these were employed for the safe keeping of records, tablets, and the like. Thus it seems that the oldest inscribed object discovered at Niffer belongs to the reign of Sargon I., who, according to the information given on the famous Cylinder of Nabonidus, reigned 3200 years before that king's time. The question which will naturally be asked next is, "To what period do the temples, the ruins of which were found beneath Sargon's platform, belong? and who built them?" At present it is impossible to give a satisfactory answer. Those who would reckon years by the depth of deposits say these temple-ruins are about 2000 years older than Sargon's platform; but this is, after all, only a guess, and if probabilities are taken into consideration we might as well date them at 10,000 B.C. as 6000 B.C., and we deprecate the use of exact figures in such matters. What is to be considered is the fact that about 3800 B.C. Sargon was able to build such a strong fortress, and that all the faculties of civilisation which such a power implied existed at that remote date. As to the earlier buildings which he found there and the platform on which they rested, they probably only stood upon the ruins of earlier buildings and of an earlier platform, and the site of Niffer being favourable for a city, it is more than likely that one stood there from time immemorial. To attempt to limit a civilisation of such antiquity as that of Southern Babylonia by thousands of years is, in our opinion, futile; though figures are useful at times to convey to the non-expert a general idea of antiquity. Mr. Haynes has proved that Niffer, in common with Tell-Lo, was one of a number of large and important cities which flourished in Southern Babylonia between 4000 B.C. and 2500 B.C., and the materials which he has obtained will enable us to describe the knowledge and religion, and manners and customs of its people with a fulness and minuteness hitherto impossible. We trust that he will soon give us his own account of the work which he has carried out, and meanwhile accord him our thanks for what he has already done, and congratulations upon the great success which he has achieved.

1 "The Babylonian Expedition of the University of Pennsylvania," vol. i., 1893; vol. ii., 1896. (Philadelphia: Reprinted from *Trans. Amer. Philos. Soc.*, N.S., vol. xviii., Nos. 1 and 3.)

THE FRESH-WATER FAUNA OF LAKE TANGANYIKA.

THE aquatic faunas of the great lakes of Central Africa, although like so many other features of the dark continent still largely unexplored, have attracted a good deal of attention during the last few years. It has been ascertained that some of these great sheets of water, although physiographically apparently so similar, are absolutely unlike each other in respect to the aquatic animals they contain. Thus the fishes and molluscs of Nyasa, which have been up to the present time by far the most completely known, show no forms which have deviated widely from easily recognisable fresh-water stocks, or that suggest that Nyasa has at any past time been more directly connected with the sea. On the other hand, one of the first items of zoological information which reached Europe concerning Tanganyika, was the discovery of a Craspidote medusa by Boehm in 1893. The mere existence of fresh-water medusæ is such a rare and remarkable occurrence, that scientific interest

became at once turned towards the Tanganyika fauna as a whole, and a re-examination of the shells of the molluscs of the lake, which had been brought home by various travellers, showed that the medusa was only one member of a remarkable fauna, many of the forms of which were as singular and marine-looking as the jelly-fish itself. Up to the present time, however, the real nature of this remarkable assemblage of lake animals has of necessity remained entirely problematical, since, without more material, it was impossible to attempt to determine whether the close similarity, which some of the gastropod shells exhibit to species living elsewhere in the ocean, was due to actual affinity, or was brought about by a convergence of variations induced somehow in an originally fresh-water stock. To obtain the material sufficient to throw light on these forms, by a determination of their actual affinities, was the object of an expedition to Tanganyika, which, through the generosity of the Royal Society and British Association, I was able to undertake nearly two years ago.

The only practical route at present open to the Lake lies up the great Zambesi water-way, which, but for the Murchison Cataracts, extends from the coast to the north end of Lake Nyasa. From this point it is necessary to march across the elevated forest land, and mountain ranges which constitute the interior plateau.

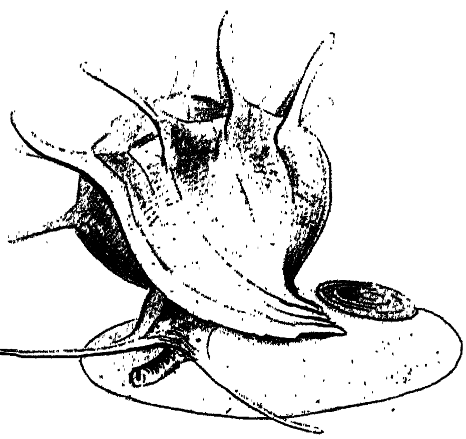

FIG. 1.—Living *Typhobia Horei.*

Approached in this direction the lake becomes first visible from the heights above Kituta, where a strip of bright green marsh-land skirts its southern coast. Descending from these heights the damp oppressive heat of Tanganyika is felt at once, and long before reaching the water's edge the forest is filled with the sickly scent which characterises the whole lake, and reminds one strongly of that of a weedy tidal beach. The lake has fallen considerably of late, and much of the coast-line is now obliterated by dense papyrus swamps, reeds, and partially submerged mimosa scrub, so that its actual shore is often very difficult to approach. In the deep water of this southern arm there are vast drift collections of empty Neothauma shells, which act as growing points for sponges, and constitute the feeding-ground of innumerable small active and entirely aquatic crabs. The living Neothaumas are found in shoaler water, generally on the flat sandy deposits which characterise the coast-line of other portions of the lake. Above the water's edge this sand has been thrown up by the wind and surf into low dunes, which are now covered with mimosa scrub and wild cotton, and beyond these, again, there is generally a strip of swamp swarming with Dactylethera, Ampularia shells, and frogs.

In many places, however, the mountains are not fringed by these lacustrine flats, and where the great western escarpments of the rift valley in which Tanganyika lies, rise perpendicularly from the water's edge, the submerged stones are covered with a bright growth of green algæ, and studded with numbers of the so-called Paramelania, a marine-looking gastropod, the affinities of which are not yet known. The great range of variation which these shells exhibit is most remarkable, and their differentation seems to be a simple function of the depth at which the shells exist, those with the most prominent processes being the lowest.

The different kinds of coast-line, which I have just described, are more or less characteristic of the whole lake, and each has a fauna peculiar to itself; but, on the flat sandy beaches, all sorts of shells, fish-bones, and the like are thrown up together by the waves, so that it is some time before one ascertains the habitat of each. Thus I observed the exquisite spined Typhobia shells two months before I found a specimen alive, owing to the fact that Typhobia, together with some curious associated forms, inhabit the profound depths of the lake, and are only to be obtained by dredging with lines of from five to seven hundred feet.

Like Neothauma and Paramelania, these deep-water gastropods are all viviparous; but while the first deposits

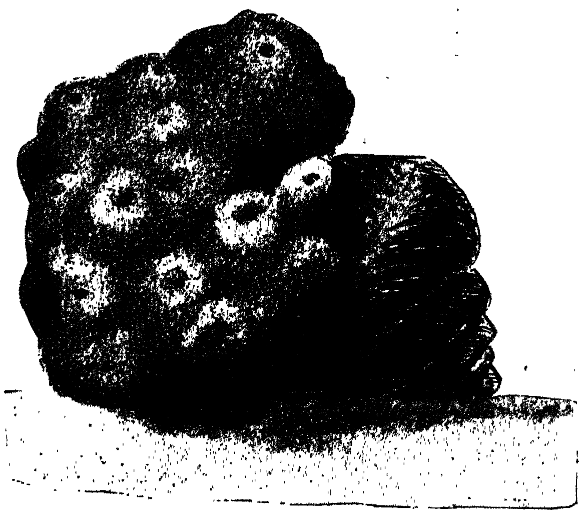

FIG. 2.—Sponge growing on dead shell of Neothauma.

only two or three large embryos at once, Typhobia produces a great number of bright green young. In this form all stages of development are present in the same animal, and we have, therefore, embryological material which may throw much light on the affinities of an aberrant group. It would be unprofitable for me, as yet, to enter into any discussion of the comparative morphology of these forms; but it may be interesting to note that, while the radula formula of Neothauma approximates in character to that of Paludina, that of Typhobia and its associates is almost unique, and although the Paramelanias show some similarity, in this respect, to the forms with which they have been provisionally associated, the radula of the so-called Lythoglythus of Tanganyika is absolutely unlike those of the forms to which it has been thought to belong.

Typhobia and its allies inhabit the flat mud bottom of the lake, and the mud itself contains numerous spiculæ, which, on treatment with nitric acid, are seen to be siliceous, many of them being indistinguishable from those of the sponge Potamolepis, found as an encrusting species in the Congo, but which I have not seen living in Tanganyika.

In many places the precipitous coast-line of the lake has been cañoned out by waves and storm-torrents into a succession of superb rocky headlands, and in the still waters of the recesses, which they partially enclose, there are innumerable swarms of prawns, some of which are certainly Palœmon-like in structure; but I am not yet sure of the affinities of them all. Like those of the Lago di Garda in Italy, lake prawns are generally supposed to have migrated up the rivers from the sea; but it is curious that they should have found their way 2700 feet up into Tanganyika, and yet not have reached Nyasa, which is so much nearer the coast.

It would be impossible within the limits of this article to give any account of the widely different forms of Tanganyika fish; but there is a curious and, I believe, quite new example of protective mimicry exhibited by a small chromis, which, in order to escape from the swarms of kingfishers along the shore, has simulated the bands of colour, size, and mode of swimming of a leech.

There appears to be only one species of medusa in Tanganyika; but this species, like so many of the lake animals, is subject to wide variation, and if the intermediate forms could not have been obtained, the extremes would certainly have been regarded as distinct species. They are rather local in their distribution, and are not always easy to find, but in some places they exist in countless numbers, and are seen at every depth, slowly pulsating after the manner of jelly-fish, till they reach the surface, and then sinking again motionless with their array of long tentacles standing stiffly up above the bell.

Towards evening the deep water of the lake is often filled with a finely-divided substance, that glitters in the sunshine like precipitated gold, and this appearance is found to be caused by the sculptured shells of swarms of Peridinia, together with a number of large infusoria, the broad bands of cilia and undulating membranes of which show them to be related to the Condylostomas. The appearance produced by this assemblage of pelagic protozoa is probably what Livingstone described in his last journal as a yellow scum on the surface of the lake, attributing it to some vegetable form.

The assemblage of animals which I have just described appears to be almost entirely restricted to the confines of the lake, and it is this geographical isolation to which at present I would draw attention, as it is, without doubt, among the most remarkable characteristics which the fauna possesses. In fact, the presence of such an assemblage of animal forms in an inland and greatly elevated lake is only intelligible by supposing either that the lake itself was at one time connected with the sea, and that its fauna is a collection of types which have persisted as survivals of an oceanic series that has elsewhere passed away, or that its marine characters are due to parallel development, produced in a fresh-water stock by the action of some conditions obtaining in an immense inland lake. I would at present offer no opinion as to which of these surmises is likely to prove correct; but whatever supposition may be entertained, it becomes obvious that the fauna of Tanganyika is comparatively old, for it is unlike anything now inhabiting the sea, and if it is derived from a previous fresh-water stock, much time would be required for the evolution of its widely-divergent present forms. This conclusion as to the comparative antiquity of the Tanganyika fauna is, in my opinion, the most important which can be drawn with certainty from a cursory survey of the facts; and, without attempting to push comparisons at present, the remarkable similarity between several varieties of Paramelania and those of the equally variable Jurassic genus Purpurina, between other varieties of Paramelania and the American and Southern European Pirguliferas, should be fully borne in mind. The determination of the actual affinities of the Tanganyika forms, which are often exclusively related to the lake, can only be made by a prolonged comparative study of the morphology of each, and it would be at present useless to speculate on the result. I have here only indicated some of the peculiarities of the fauna of the lake as they present themselves to a naturalist on the spot, the actual results of the investigation having yet to be produced.

J. E. S. MOORE.

THE LAWRENCE MEDAL.

WE are glad to be able to give a reproduction of a fine gold medal of Sir William Lawrence, now in the Royal Academy Exhibition, designed and executed by Alfred Gilbert, R.A. It forms part of a scholarship, founded in memory of Sir William Lawrence at St. Bartholomew's Hospital, and is given annually. The medal, cast and chased, $2\frac{1}{4}$ inches in diameter, shows the face and head in high relief, and gives striking evidence of the artist's skill, as the likeness well preserves the

dignity and intellectual power of the original. The view is nearly full face, not the usual profile, a treatment of which there are but few examples, either ancient or modern, and of difficult execution. The reverse has an allegorical subject suited to the aim of the scholarship, and instinct with the grace and fancy of which Mr. Gilbert is master. A youth, full of confidence, presses through the shield dividing him from life, whilst wisdom and science on either hand whisper counsel as they point to the motto on the shield, part of the line from Homer,

"αἰὲν ἀριστεύειν καὶ ὑπείροχον ἔμμεναι ἄλλων," often cited by the original of the medal.

A few notes follow, on a less well-known side of Sir William Lawrence's early work, from the pen of a distinguished pupil.

IN MEMORY OF LAWRENCE.

In the domain of surgery the name of Lawrence is held in high honour as that of a practitioner and observer of the utmost skill and originality. As a teacher at St. Bartholomew's Hospital and in the theatre of the College of Surgeons his services to the profession which he had adopted are recognised as having been invaluable. It is, however, not perhaps so well known that he was also a pioneer in those branches of research which more recently, under the direction of Darwin and Wallace, have effected such a revolution in our conceptions of the great scheme of zoological development. Not that it can be claimed for Sir William Lawrence that he anticipated the modern creed as to the descent of man, for he expressly repudiated the tenet of a common line of ancestry for man and brutes. Still, however, his lectures on the "Natural History of Man," delivered as professor to the Royal College of Surgeons, were far in advance of the opinions of the day, and were full of new thought and suggestion. They were published in 1816, and went through at least eight editions. Although now superseded by other works, they are still a mine of carefully collated facts to which the student refers with pleasure and profit. As is well known, they brought upon their author a storm of persecuting zeal, at the head of which was Abernethy, Lawrence's senior colleague at the hospital! In a second course of his college lectures Lawrence referred to these proceedings, and in a tone of manly independence claimed the right to think for himself and to express his opinions in his own terms. "These privileges, gentlemen, shall never be surrendered by me; I will not be set down nor cried down by any person, in any place, or under any pretext. However flattering it may be to my vanity to wear this gown, if it involves any sacrifice of independence, the smallest dereliction of the right to examine freely the subjects on which I address you, and to express fearlessly the result of my investigations, I would strip it off instantly." This was bold language in a young man, and one who in his profession was of course a candidate for public favour. It was indeed by this high endowment of moral courage that Lawrence was enabled to approach the topics which he treated of in a manner which was so far in advance of the current modes of thought, and so eminently advantageous to the age.

Lawrence's personal bearing was an index of his character. His stature was tall and his manner dignified, and his face was, in its expression of intellectual calm, one of the noblest ever worn by man. JONATHAN HUTCHINSON.

JULIUS SACHS.

JULIUS SACHS[1] was born at Breslau October 2, 1832, and died at Würzburg on May 29, 1897. Although his health had been seriously impaired for years, his last illness was not of long duration. He was regularly at work in his laboratory during the Easter vacation, and only took to his bed about the middle of April. A few days before the end came, he sank into coma and died without pain. Of his early career I have not been able to learn anything: I remember to have heard him say that his first teacher was Purkinje, under whom he published two or three zoological and geological papers. His first official post was that of Privat-Docent at Prague. In 1858–59 he was at Tharandt, in 1860 at Chemnitz. In 1861–62 he was appointed Professor in the Landwirthschaftliche Institut at Poppelsdorf, near Bonn. In 1867 he was called to the chair of Botany in Freiburg, and in 1867 he obtained the professorship at Würzburg, which he held up to the time of his death.[2]

It is not easy for a botanist of these days to estimate the debt of gratitude that he owes to Sachs. We have grown up in the modern school, and we mistake for our natural environment a state of things which his labour of forty years painfully built up for us. There is a natural blindness of the child to the parent, or the apprentice to his master, and this we can only partially overcome.

The place of Sachs in the history of Botany is, I am inclined to think, even higher as a teacher than as a discoverer. He will be more permanently known for his "Experimental Physiologie" (1866), by his "Lehrbuch" (first edition, 1868),[1] his "Geschichte der Botanik" (1875),[2] and his "Vorlesungen" (1882),[3] than by his "Collected Papers" (1892–93). The earliest of these volumes, the "Experimental Physiologie," seems to me in some respects the best. If we compare it with previous books on the physiology of plants we feel an enormous advance, not only in the fire and vigour with which it is written, but especially in the absence of compilation; it reads like an original paper rather than a treatise, and it was in fact largely founded on the activity of twelve of the best years of his life. Between 1853, when his first paper appeared in the Czechish journal *Ziva*, until 1865, just before the publication of the "Experimental Physiologie," he published (according to the Royal Society's Catalogue) sixty-eight papers, of which, however, the two or three earliest ones were not botanical. The book gives internal evidence of being written with the delight of a strong man in his work, and Sachs has been heard to say that he wrote it with a pleasure greater than that given by any of his later books.

On the other hand he spoke, if I remember aright, somewhat wearily of the years of section-cutting and microscopy needed for his "Text-Book." This may serve to remind us of what we are apt to forget—the mass of original matter hidden in this admirable book. In his last book, the "Lectures" of 1882, he returned to what best suited his turn of mind—a broad, general view of physiology. At the same time he handed over the re-editing of the histology, the detailed morphology and classification in the "Text-Book," to his friend and pupil Goebel.[4]

The "Text-Book" has no doubt had a greater effect on botany than any one of his other books. The modern botanist is sometimes assumed to be ignorant of taxonomy, but a man who has worked practically through Sachs' "Text-Book" knows more of the classification of the vegetable kingdom as a whole, than the older botanist who knew the phanerogams minutely, but little beyond them. As a single proof of the fruits arising from a proper understanding of the taxonomy of plants, it may be pointed out that palæobotany has only been rendered possible as a science by the sort of knowledge inculcated by Sachs. Witness the work of Solms Laubach and Nathorst and others on the continent, and of Scott and Seward in this country, as compared with the efforts of earlier workers. The effect of Sachs' "Text-Book" in England was intensified by the great revival of scientific teaching instituted by Huxley, in which the all-importance of practical work was insisted on. And thus the learner of those days had the good luck to be supplied with Sachs' "Text-Book" just when he was spurred on by his teacher and by the spirit of the times to examine the histology and physiology of plants for himself.

As a teacher in the laboratory Sachs' position was equally great. He was most generous in receiving pupils, and those of us who had the good fortune to be of that number must always remember with gratitude his genial welcome and the pains he took with us over our work. To some it was a first introduction to a research laboratory, to a region where, if examination is not quite

[1] I believe that Sachs never made use of the title of *von*, which was conferred upon him.

[2] For the above facts I am indebted to the kindness of Prof. Kunkel of Würzburg, and Prof. Marshall Ward.

[1] The English translation of a later edition appeared in 1874, under the name of "Text-Book."

[2] English translation, 1890.

[3] English translation, 1887.

[4] English translation, under the title of "Outlines of Classification, &c.," 1887.

banished, it is so much in the background as to be forgotten. It was extraordinarily invigorating to fall into the midst of a group of young men each engaged in his problem, and ruled over by a kindly despot full of resource and enthusiasm, and both willing and able to give us questions to solve. His tendency was to do things in a broad, handsome manner. He liked to have a flush of material, and he sacrificed it royally; for instance, in his work on roots he used 3000 beans. He insisted on things being done in a sound, cleanly manner, and especially inculcated the proper cultivation of experimental material, often reproving his pupils if they did not give light enough to their plants. He liked the practical details of cultivation, and would take pleasure, for instance, in showing his pupils the proper way of moistening earth for germinating beans; with the remark that this ought not to be done by a gardener, and adding "Das macht mir Spass" as a further reason for doing it himself. He preferred simple methods and broad results, and was essentially a man of round numbers. He did not deal in elaborate apparatus, and had indeed a somewhat unreasonable dislike for "Sogenannte Genauigkeit." But this was rather the dislike of unnecessary exactness, or of exactness misplaced—a valuable point of view in an experimentalist. He had, however, a liking for mechanism, as his invention of the recording auxanometer and of the klinostat shows.

As a lecturer he was admirable, and illustrated his words on the blackboard with evident pleasure and in the most life-like of sketches.

His papers have been collected in two volumes, published in 1892-3, many of the researches having appeared in his celebrated "Arbeiten," three well-known volumes, in which it was the highest ambition of his pupils to obtain a place.

The main point that strikes one about his work is that his was pure rather than applied physiology; he cared for the behaviour of a plant as he cared for a machine, not in relation to its environment. He was essentially not a biologist in the modern sense, though, as a matter of fact, he was an evolutionist.

His work may be divided, as he has himself classified it, into the physiology of nutrition and that of movement. In both these departments he laboured incessantly, and made numerous important discoveries; yet, in spite of what he added by his admirable researches, it seems to me that he was even more remarkable for his power of strengthening and marshalling a subject, and of placing it before the world with a vigour and clearness that ensured its acceptance.

Thus, in regard to nutrition, he established, by the most brilliant of his researches, the connection between carbon-assimilation and the existence of starch in the chloroplasts; yet his fame seems to me to rest with even greater certainty on the fact that he saw more clearly than any modern botanist the overwhelming importance of a just view of assimilation, and that he had the intellectual force needed to drive it into the minds of a generation of botanists.

In the same way he marshalled, remodelled and largely added to our knowledge of growth and growth-curvatures, and set forth his results with a style and force that were irresistible. But the conception of stimulus and reaction, now the central principle of plant—as of animal—physiology, only came to him imperfectly, as it seems to me. His use of the word *anisotropic* for organs behaving differently in relation to the same cause, implies a certain want of perception of the heart of the matter. The word is not really wanted, since the conception of irritability postulates what he called anisotropy. The stimulus is but a sign-post; the needs of the plant in relation to its environment necessitate that different organs shall be guided by the stimulus in opposite directions.

In spite of the strength and clearness of his way of thinking, there was in him a vein of something like mysticism, as, for instance, in his conception of a radial organ as corresponding to a dorsiventral organ rolled up like a scroll; or in his assumption of an invisible dorsiventrality in certain plagiotropic organs.

Again, there is in his views what strikes some of us as almost mediæval. For instance, his idea of the root-forming and shoot-forming material flowing in opposite directions, and thus accounting for the behaviour of cuttings. The same may be said of his views on etiolation, although in these days of the thyroid treatment of myxœdema it is rash to deny the feasibility of any explanation founded on the special nutrient value of definite substances. But it is juster to put aside these considerations, and in a broader spirit to remember only the masterly way in which, in his "Lectures" (1882), he developed the classification of organs into "root" and "shoot" into a system of physiological morphology, *i.e.* into a morphology which goes beyond phylogeny into the region of adaptation.

I have thought it right to speak plainly about Sachs' work, for I am assured that it contains so much of enduring value that it deserves the truth; and I willingly allow that in the points in which my estimate of this great man is less favourable than some of my contemporaries, I may be misled by that blindness of which I have already spoken.

In his later years his life was overshadowed by broken health, and his nature—sensitive and self-centred—was never compatible with a serene or happy life. Those who came under his influence must be glad to forget the less happy side of the picture, and remember with gratitude how much they owe to Sachs.

FRANCIS DARWIN.

PROFESSOR R. FRESENIUS.

CARL REMIGIUS FRESENIUS, whose death occurred last week, was born at Frankfurt-on-Main on December 28, 1818. After a preliminary training at a pharmacy in that town, he devoted himself to the study of natural science, more especially of chemistry and botany. In 1840 he entered the University of Bonn, but a year later went to Giessen, where Liebig chose him as assistant in his laboratory. He graduated at Giessen in 1843. In 1845 he was called to the professorship of chemistry, physics, and technology at the Agricultural Institute at Wiesbaden, with which he has since been identified. The chemical laboratory at Wiesbaden, founded, owing to his exertions, in 1848 by the Government of the Duchy of Nassau, has since been much enlarged, a school of pharmacy being added in 1862, and a research laboratory for agricultural chemistry in 1868. The direction of the latter was taken over by his son, Dr. Henry Fresenius, in 1881. Fresenius received the title of Geheim Rath of the Duchy of Nassau in 1855. His best-known works are his "Qualitative Analysis" (first published in 1841) and his "Quantitative Analysis" (published in 1846); both have passed through very numerous editions, and have been translated into almost every European language. His numerous original memoirs (there are 162 titles in the Royal Society's Catalogue between the years 1842 and 1883) deal almost exclusively with analytical chemistry. One of his earliest papers (1843) deals with the composition of a mineral water from Java, and this was a subject to which he frequently returned. A series of papers on the mineral waters of Nassau (1864-68) are well known. Many of his later papers are published in the *Zeitschrift für Analytische Chemie*, which he founded in 1862, and which he continued to edit until his death.

T. E.

NOTES.

M. HATT has been elected a member of the Section de Géographie et Navigation of the Paris Academy of Sciences, in succession to the late M. d'Abbadie; and Prof. de Lapparent, professor of mineralogy, geology, and physical geography in the Paris École libre des hautes études, has been elected a member of the Academy, in succession to the late M. des Cloizeaux.

WE regret to announce the death, at sixty-seven years of age, of Prof. P. Schützenberger, professor of chemistry at the Collège de France, and member of the Paris Academy of Sciences.

M. MAURICE LÉVY AND M. LÉAUTE will represent the Paris Academy of Sciences at the inauguration of the statue of Perronet at Neuilly, on Sunday next, July 4.

THE eightieth annual meeting of the Société helvétique des sciences naturelles (the Swiss Association of Naturalists) will be held at Engelberg, in the pretty Alpine village of Engelberg (Obwalden), on September 12–15. The Committee has issued a very cordial letter of invitation, in which it is pointed out that though Engelberg does not offer the resources and pleasures of a large town, or exhibit such a solid testimony to scientific movement as is seen at Zürich, where the Association met last year, nevertheless the little village at the foot of snow-capped Titlis has attractions of its own, and the welcome which will be extended to the members will be a very hearty one. The meeting will open with a reception at five o'clock in the evening of Sunday, September 12. On the following day there will be a general meeting, after which an excursion and a banquet will be the order of the day. On September 14 the sections will meet in the morning, but the afternoon and evening will be devoted to lighter pleasures. The second general meeting will take place on September 15, and the session will be closed on the same day. The railway and steamboat companies offer special facilities to members of the Association, and the charges at hotels will be reduced. The hearty invitation of the Committee, and the place of meeting (in one of the most beautiful valleys of the Alps), will doubtless attract many men of science to go with friends or families to Engelberg next September. It is hoped that those who propose to attend the meeting will notify their intention before the end of July. Letters should be addressed to the President of the Annual Committee, Herr E. Etlin, Arzt, Sarnen, Obwalden.

THE Albert Medal for the present year has been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society of Arts, to Mr. G. J. Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on, during nearly forty years, systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

THE annual meeting of the American Microscopical Society will be held at Toledo, Ohio, on August 5–7, under the presidency of Prof. E. W. Claypole.

IN the House of Lords on Tuesday, Lord Hobhouse moved the second reading of the Sunday Bill. The object of the Bill was to amend the Lord's Day Act of 1781, which is now being vexatiously used to repress attempts to improve the rational use of Sunday by means of lectures and musical performances. After discussion, the second reading was rejected by 50 votes to 33.

A PUBLIC meeting will be held in the Botanical Theatre of University College, Gower Street, to-morrow at 4 p.m., to inaugurate the personal memorial to the late Sir John Pender. Mr. Onslow Ford's bust of Sir John Pender will be on view, and a cheque for 5000*l.*, to endow the electrical laboratory of University College, will be handed over to the Trustees. The gift will be acknowledged by Lord Reay on behalf of the College. The Marquis of Tweeddale will preside, and Lord Kelvin is expected to be present and speak.

A COMMISSION, consisting of Prof. D. T. McDougal, of the State University of Minnesota, and Prof. Campbell, has lately visited Jamaica and other of the West Indian Islands, to select a site for an international botanical laboratory in the tropics. American botanists have long been considering the advisability and expediency of the establishment of such an institution, which, if it is founded, will be of great value as a permanent research laboratory.

THE New York Zoological Society is making special efforts to increase its membership and obtain subscriptions and endowments for the Zoological Gardens, to be established in South Bronx Park (see vol. lv. p. 613). The Society requires 250,000 dollars for the erection of animal buildings, aviaries, and other enclosures, and for the purchase of a series of mammals, birds, and reptiles with which to fill them. The sum of 100,000 dollars is urgently required, and should be obtained before August 1, as that amount must be pledged before any work on the proposed Zoological Park can begin. There ought not to be any difficulty in obtaining this amount if the rich citizens of the largest and wealthiest city in America have any public spirit.

AT Shoreditch, on Monday, Lord Kelvin opened a central electric station, in which the motive power is steam produced by a destructor which is to be fed with household refuse as fuel. From the *Times* we learn that there are twelve destructor cells, each having a grate area of twenty-five square feet, and heating six water-tube boilers working at a pressure of 200 pounds to the square inch. The chimney is 150 feet high and 7 feet in internal diameter at the top, and, in addition, there are three electrically-driven fans, which each deliver 8000 cubic feet of air a minute with a maximum ash-pit pressure of three inches of water. An interesting feature is the employment of Mr. Druitt Halpin's system of feed thermal storage. As it is necessary to keep the destructors burning continuously, steam is generated during all the twenty-four hours. But as power is required on a large scale during only a portion of that time, in order to reduce waste a plan of heat storage has been introduced, by which, during the day, steam is mixed in a vessel with cold water in such proportions that at evening the cylinder is full of water at the temperature and pressure of the steam required by the engines. The boilers are fed with this heated water, and are said to be enabled in consequence to produce one-third more steam than they would if working with water direct from the mains. As to the amount of refuse consumed, it is expected that the most efficient rate will be between eight and twelve tons a day. The electrical plant at present consists of three generators working at 1100 volts, and three low-tension dynamos at 165 volts. All are driven by Willans' three-crank engines, coupled direct. Orders have already been received to nearly the full capacity of the present plant. In declaring the undertaking ready for public use, Lord Kelvin said that it was worthy of the Victorian era as an example of the combination of scientific forethought, mechanical skill, and courage, which had nothing of gambling in it, but simply brought into practice recognised engineering possibilities. Dust destructors have been tried for some years in order to get quit

of refuse at a lower cost than is required for spreading it on the ground or carrying it out to sea, but little has been done in the way of using the heat of these dust-crematories for raising steam. Shoreditch is the pioneer vestry in this respect. But what has been done is only the small beginning of what will be a much greater thing, for all dust refuse will soon be used in the same way.

THE firing at Portsmouth on Saturday, on the occasion of the naval review, was distinctly heard at Hungerford, Wilts, a distance of forty-five miles, as the crow flies, and also at Great Malvern. It would be interesting to know whether the salutes were heard at greater distances than these.

IN accordance with the will of the late Prof. E. D. Cope, his collection of fossils is to be sold, and the proceeds devoted to establishing a chair of Palæontology in the Philadelphia Academy of Sciences, with which his name was so closely connected. The appointment to the chair must be approved by the National Academy, the duty being chiefly that of original research.

IT may interest some of our readers to know that the following are among the portraits recently acquired by the Trustees of the National Portrait Gallery:—Sir Francis Ronalds (1788–1873), inventor of the first working electric telegraph. A small plaster bust of Richard Jefferies (1848–1887), naturalist and author. A painting of Constantine Phipps, Lord Mulgrave, R.N. (1744–1792), represented in the Arctic regions while commander of H.M.S. *Racehorse* in 1773 on a voyage to the North Pole. Sir Joseph Williamson, P.R.S. (1630–1701), Secretary of State in 1674, and second President of the Royal Society.

A THUNDER-STORM of extraordinary violence passed over London on Thursday last, and did an immense amount of damage in Essex, every kind of crop over an area of about a hundred square miles being ruined. A description of the storm will be found in our correspondence columns. Hailstones of unusually large size fell during the thunder-storm. Mr. F. E. Allhusen, writing from Harrow-on-the-Hill, sends us a description of hailstones which fell there at about 1.50 p.m. The hail continued for about twenty minutes, and was followed by heavy rain. Referring to a number of hailstones picked up and examined within five minutes of their fall, Mr. Allhusen says:—"The majority were roughly spherical in shape, and had an opaque nucleus about the size of a pea. Round this there was a layer of clear ice, in several distinct concentric layers. The ice was honeycombed with small air-bubbles, arranged radially; many of these air-bubbles were much elongated. The general appearance of the hailstones was rough, and somewhat similar to that of the edible part of a walnut. . . . Twelve fairly large stones were weighed; they turned the scale at two ounces."

MR. J. A. MCMICHAEL, Head-master of the Technical Day School, Chester, informs us that on Sunday evening, June 20, at 7.45, he saw a distinct solar halo. The angle subtended by its radius was roughly estimated at 25°. No second halo was visible. The colours were easily seen, the red being inside. Mr. McMichael thinks the appearance of such a phenomenon four days before Midsummer Day is very remarkable, and would like to know if any of our readers could give similar instances.

IT is stated in *Science* that a Bill has been introduced in the Minnesota Legislature providing for the appointment of expert witnesses, and that a similar Bill has been prepared to be presented to the New York Legislature. The object of the Bill is to provide a list of experts from whom witnesses are to be selected by the Court and paid by the State. The following remark of our Transatlantic contemporary will find many supporters:—"The employment of expert witnesses by the counsel for the prosecution or defence has been unfortunate both for the Courts and for science. It would certainly be desirable to devise a plan by which the expert witness should be in the position of a judge rather than that of a paid attorney."

THE number and variety of scientific exploring expeditions in America this summer is surprising. The latest announcement is that Prof. Wm. Libbey, jun., of Princeton University, will in a few days lead a party of six explorers to Albuquerque, New Mexico, to explore a mesa or sandstone tableland near there. The outcroppings of red sandstone project from the face of the walls, rendering it almost inaccessible. Cliff dwellings have been seen along the edges, and fragments of pottery at the base indicate occupancy by a pre-historic race; but the tableland has never been scaled in historic times, so far as known. Prof. Libbey intends to throw a line over this tableland, which is several acres in extent on top, by means of tandem kites; or, in case the wind should be too light, by means of a mortar which will fire a life line across the top. Larger lines will be drawn over, and the ascent made in a boatswain's chair.—Mr. Jesse D. Grant, son of General Grant, is sending an expedition to explore the islands in the Gulf of California, north of 29°, which parallel intersects Tiburon Island, inhabited by the fierce and little-known cannibal Ceris Indians.

TWO exploring expeditions are now on their way to Mount St. Elias—one from the United States, the other from Italy. The object of the American expedition is to make a survey of the region, and settle the boundary dispute with Great Britain. The 141st meridian of west longitude is the boundary line, and the summit of the mountain was found by the commission appointed in 1891 to be approximately 60° 17′ 51″ N. and 140° 55′ 30″ W. It is said to be thirty-three miles inland, whereas the jurisdiction of the United States extends ten marine leagues or 34½ miles; thus, it would seem, taking in the summit. Mr. E. B. Tatham, of the United States Coast Survey, will conduct this work. The party will be led by Mr. Henry G. Bryant, of Philadelphia, who explored the great falls of Labrador in 1891, and was leader of the Peary Auxiliary Expedition in 1894. Mr. Samuel J. Enterkin, who goes with the party, was with the Peary party on its journey to the ice cap in March 1894.

THE Italian expedition to Mount St. Elias is led by Prince Luigi Amadio of Savoy, who is accompanied by four aides, Chevaliers M. Cagni, Francesco Gonella, Vittoria Sella, and Dr. Filippo De Filippi. After the ascent, this party will attempt to climb Logan's Peak. Mount St. Elias is over 18,000 feet high, and was for a long time considered the highest mountain on the American continent. The summit has never been reached, though several attempts have been made, notably in 1891, when the surveying party reached the height of 14,500 feet. The reason of the failure of former parties is said to be that the approach was made on the south side, where there is a heavy fall of snow and tremendous avalanches, glaciers, precipices, and chasms. The northerly side, from which the ascent will now be attempted, is more approachable, owing to a long ridge of mountains.

WE learn with regret that Mr. W. J. C. Millar has been compelled by ill-health to resign the post of mathematical editor of the *Educational Times*, which he has held for the past forty years. Mr. Millar's labours have been purely honorary, and his collections of problems and mathematical riddles have inspired and directed the early efforts of many mathematicians of the highest eminence, including such names as Clifford, Cockle, Cayley, and Sylvester. It is now

proposed to present Mr. Millar with a testimonial in recognition of his services, and towards this purpose 40*l*. has been already received. The Rev. Robert Harley, F.R.S., of "Rosslyn," Westbourne Road, Forest Hill, S.E., has kindly undertaken to receive contributions, which it is hoped will be "*numerous* rather than *large*," the object being to show Mr. Millar how widely his work has been appreciated.

IT is somewhat remarkable that, although the conception of the centre of gravity was evidently known to Archimedes, those of his writings which have been handed down to us nowhere contain either a definition or a proof of the existence of that point. This gap has been attributed to his having treated the subject in a lost work on balances, quoted by Pappus. An important contribution to our historical information has now been made by Dr. Giovanni Vailati (*Atti della R. Accademia delle Scienze di Torino*, xxxii.), who has found fresh material in an Arabic translation of an unknown work by Hero, of Alexandria, in the library of Leyden. This work was brought over in the seventeenth century by Golius, then Professor of Mathematics and of Oriental Languages in the University of Leyden, and attention has recently been directed to it by Carra de Vaux. In it Hero makes numerous references to Archimedes' lost manuscript, from which Dr. Vailati has been enabled to build up, with a fair degree of certainty, the arguments by which Archimedes proved the existence of the centre of gravity.

DR. F. CAMPANILE and Dr. E. Stromei (*Rendiconti dell' Accademia delle Scienze di Napoli*, iii. 4) describe some further experiments on the phenomena of phosphorescence observed by them in Crookes and Geissler tubes. This phenomenon consists in the production of phosphorescence and Röntgen rays on the walls of a Geissler tube opposite two plates of tinfoil which were attached to a Ruhmkorff coil or to an electrostatic machine, connected with a spinterometer.—A somewhat different line of investigation has been taken up by Prof. Battelli (*Nuovo Cimento*, v., March 1897), who has studied the variations in the photographic action both inside and outside a vacuum tube, and their dependency on the form and dimensions of the tube, the form of the electrodes, the intensity of the current, and the degree of rarefaction.—In a subsequent number of the *Nuovo Cimento*, Signor P. G. Melani discusses the influence of magnetism on discharges in vacuum tubes, and describes a number of experiments carried out in Prof. Battelli's laboratory at Pisa.

ALONG with a fine series of reptiles lately presented to the Zoological Society's collections, Mr. F. W. Urich has sent from Trinidad a nest of the "Sauba" or Parasol Ant, *Œcodoma cephalotes*, the extraordinary habits of which are well known to naturalists. The colony has been placed in a glass case in the Zoological Society's Insect House, where the workers may be seen every day cutting out bits of leaves from a plant that has been provided for their use, and conveying them into their subterranean dwellings.

A NEW Tortoise House, placed near the Reptile House, has just been completed in the Zoological Society's Gardens, and the various specimens of the *Testudinata* will shortly be removed there from their present quarters on the further side of the canal, so that the whole of the reptile collection will be together. The most remarkable of the tortoises are two fine adult specimens of the Giant Tortoise of the Aldabra Islands in the Indian Ocean, which were presented to the Society by Rear-Admiral Kennedy in 1894. There are also three other examples of the same, or of a nearly-allied species, which have been recently received "on deposit" from the Hon. Walter Rothschild.

AUTHORITIES on Indian birds seem to be unanimous in the opinion that the common little Cotton-Teal or Goose-Teal, *Nettopus coromandelianus*, is unable to stand and walk like other ducks, but invariably flutters along in a strange scuffling manner, like a wounded bird. At a recent meeting of the Asiatic Society of Bengal, Mr. F. Finn gave reasons for doubting the accuracy of this statement. He has had many opportunities of observing Cotton-Teal in confinement, and after watching the gait and movements of numerous specimens, he asserts that the inability to walk, attributed to the species by many observers, is not in reality natural to it, but merely the result of fright, weakness, or injury.

Science Gossip for June reproduces from the *Journal of Malacology* some very interesting sciagraphs of shells by Mr. W. M. Webb, which seem to show that the Röntgen rays are of practical value for studying their interior structure. In a paper read before the Natural History Society of Buda-Pesth, Dr. J. Istvánffy states that, in the case of living plants, the Röntgen rays penetrate only the woody tissue. In a leaf of *Camellia* exposed to them, the veins appeared white. All other tissues, whether containing chlorophyll or not, are impenetrable to them.

WE are glad to see that the *Gleaner*, of Kingston, Jamaica, is urging the appointment of a geologist to examine the new sections which will be exposed during the construction of a new road now being made over the mountains. The palæontology of Jamaica has been very little studied. There is a very poor collection of fossils in the local museum. It is a little better with mineralogy, but so slight has been the interest taken in all branches of geological science that there are both fossils and minerals from local sources in the museum, about which there is absolutely nothing known; all trace of their origin and other circumstances having been lost. What is really wanted is a Government geologist, to devote himself exclusively to geological observations; and if the appointment of such an officer cannot be entertained at present, the least that should be done is to commission a geologist to map the sections which the road-builders will expose, and save whatever vestiges of vanished ages may be obtained. The facts thus accumulated would be of the greatest value when a survey of the country comes to be made.

MESSRS. GINN AND CO. will shortly publish the first number of the *Zoological Bulletin*, a companion serial to the *Journal of Morphology*, and designed for shorter contributions in animal morphology and general biology. The *Bulletin* will differ from its German prototypes chiefly in excluding, at least for the present, bibliographical lists. Its contents will consist wholly of scientific communications. The editorial work will be directed by Profs. C. O. Whitman and W. M. Wheeler.

IN connection with the excursion of the Geologists' Association to Edinburgh, from Monday, July 26, to Saturday, July 31, the four following papers will be read at a meeting of the Association at University College, London, to-morrow, July 2, at 8 o'clock:—"Outline of the Geological History of the Rocks around Edinburgh," by Mr. J. G. Goodchild; "Excursions from Bathgate to Linlithgow, and from St. Monans to Elie," by Prof. James Geikie, F.R.S.; "Fish Remains in the Abden Bone-bed," by Dr. R. H. Traquair, F.R.S.; "The Stirling District," by Mr. H. W. Monckton.

THE Report of the Government Observatory, Colába, Bombay, for the year ended March 31 last, presents two special points of interest: (1) The introduction of a Dines' pressure tube anemometer, the vane of which is erected about 3 feet above the cups of the Robinson anemometer, and about 6 feet from it. A comparison of the results of the two instruments during the short period of the erection of the new anemometer shows that the average velocity recorded by the old instrument is 42 per cent. more than the average velocity given by the

Dines' anemometer, confirming the results of other observers that the factor 3 (the ratio of the speed of the wind to that of the cups) is too great. (2) The Director is able to report a clean bill of health in his little colony (numbering altogether about 100 persons, including servants and their families) during the plague epidemic. This satisfactory state is attributed to additional ventilation, by removal of tiles, &c., to fumigation twice a week by carbolic acid, to inoculation of every man, woman, and child with Dr. Haffkine's prophylactic serum, and to the daily inspection of the quarters and inmates.

THE additions to the Zoological Society's Gardens during the past week include a Servaline Cat (*Felis servalina*) from East Africa, presented by the Rev. Ernest Millar; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. M. A. Murray; a Common Squirrel (*Sciurus vulgaris*), British, presented by Lady Acland Hood; two Bateleur Eagles (*Helotarsus ecaudatus*), two Common Herons (*Ardea cinerea*) from East Africa, presented by Mr. Chas. Palmer; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Edith M. Kenyon Welch; a Grey Monitor (*Varanus griseus*) from Egypt, presented by Dixon Bey; two Natal Pythons (*Python sebæ*, var.) from Natal, presented by the Hon. R. Carnegie; an Orang-outang (*Simia satyrus*, ♂) from Sumatra, deposited; two King Penguins (*Aptenodytes pennanti*) from the Antarctic Seas, purchased; a Burchell's Zebra (*Equus burchelli*, ♀), a Japanese Deer (*Cervus sika*, ♀), two Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

PERSONAL EQUATIONS IN TRANSIT OBSERVATIONS.—In the reduction of transit observations the question of personal equation is an important factor in the accuracy of the final star places, and it is on this account that investigations are always being pursued to determine the values of these equations for each meridian observer. A communication of importance in this respect appears in the *Monthly Notices* for May, by Prof. Truman Safford, who treats of the various forms of personal equation in transit observations which arise from the non-observance of the exact time of transit due to personality, magnitude of the star observed, and the apparent velocity and direction of movement. In his investigation Prof. Safford concludes that since the year 1795 most eye and ear observers anticipate the true time of transits, taking the average observed as a standard. At Greenwich, since 1885, the great majority of observers by the eye and ear method anticipate the time of their own chronographic transits, while the average chronographic observer registers transits after the time of their occurrence by an amount not greatly different from that which is required to register an impression on the senses. The personal error arising from the rate of movement of the star, or as it is termed the polar equation, amounts sometimes to a very considerable quantity, and several values are given in the paper showing the importance of a strict elimination of this variable. Dealing with faint stars an observer using the chronographic method registers its time of transit later than that when a more bright one is taken, while with the eye and ear method the time of transit is generally somewhat earlier. The change in direction of motion of stars due to their being observed sometimes north and sometimes south of the zenith, gives rise to a further personal equation discovered by Dr. Gill, but which is found generally very small. The investigation shows that the general theory thrown out by Bessel is thus confirmed, and Prof. Safford points out that the same is true with regard to Wundt's explanation of the eye and ear process from a psychological point of view.

PARIS OBSERVATORY REPORT.—In his annual report for the year 1896, M. Lœwy, after a brief reference to the loss the observatory sustained in the death of M. Tisserand, sums up the work of the past twelve months. Among some of the chief points to which reference is made, may be mentioned the two astronomical congresses that have been held at the Observatory, and the work connected with the great enterprise of the photographic chart of the heavens. Many of the difficulties connected with the latter have for the great part been overcome, but there still remain one or two important questions which have been left over for another meeting. M. Bigourdan's work on the determination of the accurate position of the nebulæ between declination 90° and −30° has made great progress, and it is expected that it will take him three years more to complete the whole region under survey. The work on the photographic atlas on the moon has been successfully continued, and besides the issue of the first portion of the atlas during the past year, a second one will be published in the present one. The report further gives a brief account of M. Deslandres' work on the motions of stars in the line of sight, and the results of the expedition to Japan to observe the solar eclipse of August last. The work done in other departments of the observatory during last year, such as the Bureau des Calculs, Service Meridien, &c., is also briefly described.

BELGIAN TIME-RECKONING.—Since the beginning of May, the hours in Belgium have been reckoned from 0 to 24, noon being represented by 12, and midnight by 0 or 24, according to circumstances. In the case of a train starting exactly at midnight, it is said to leave at 0 hour; and one arriving exactly at midnight is considered due at 24 hours, or, as we should say, at 24 o'clock. We learn from the *Journal* of the Society of Arts that on the time-tables the times between midnight and 1 a.m. are indicated by a zero, followed by a point and the letter H, the latter followed in turn by the number of minutes. The dials of existing clocks at railway stations are completed by the figures 13, 14, 15, &c., to 24, added below the existing figures of 1, 2, 3, &c., to 12. This change, which should have come into force with the new year, was deferred for three months, on account of the administrative difficulties which it involved, and also in the hope that the Greenwich meridian, now adopted in Belgium, might also be accepted by France at the same time, urgency having been voted for a measure to that effect by the Chamber of Deputies.

A NEW CLASSIFICATION OF STELLAR SPECTRA.[1]

MANY of the recent advances in our knowledge of the constitution of the stars are traceable to Prof. Pickering's revival of Fraunhofer's mode of investigating stellar spectra. The endowment of this research by Mrs. Draper as a memorial to her husband, Dr. Henry Draper, has enabled Prof. Pickering to apply this method in two principal directions. First, a series of photographs was taken on a small scale to indicate the chief characteristics of the spectra of a very great number of stars; second, in the case of the brighter stars, another series was taken with greater dispersion with the view of facilitating an inquiry into the more minute features of each type of spectrum. The results of the first investigation are comprised in the well-known "Draper Catalogue," giving particulars of the spectra of over 10,000 stars (NATURE, vol. xlv. p. 427), and the research has now been advanced another stage by the publication of the results obtained along the second line of inquiry.

The new series of photographs has been taken with one to four objective prisms of 15° each in conjunction with the 11-inch Draper telescope of 153 inches focal length.

When four prisms were employed, the spectra were 8 centimetres long from H_β to H_ϵ, and with one prism 2 centimetres. Since only the brighter spectra could be photographed with the highest dispersion, some of the more typical of these were also photographed with one and two prisms in order to give a proper term of comparison with the spectra of the fainter stars. In all, 4800 photographs of the spectra of 681 of the brighter stars north of declination −30° are included in the present discussion. By the use of plates stained with erythrosin the spectra of several stars have been photographed in the green and yellow.

As in all previous work involving considerable numbers of stellar spectra, it has been found that the spectra can be classified in large groups, between which there are intermediate varieties. "Large numbers of almost identical spectra are found, even when several hundred lines appear in each." The description of the spectra accordingly takes the form of an account of typical stars in the scheme of classification adopted, accompanied by tables of the lines which characterise the larger groups. No

[1] Spectra of bright stars, photographed with the 11-inch Draper telescope as a part of the Henry Draper Memorial, and discussed by Antonia C. Maury, under the direction of Edward C. Pickering. (*Annals of Harvard College Observatory*, vol. xxviii. part 1, 1897.)

attempt has apparently been made to assign chemical origins to the various lines, so that the endeavour to arrive at a natural and satisfactory system of classification may be regarded as the most important part of the discussion.

The classification of stars has another object besides that of the mere grouping together of those which have similar spectra. It is generally believed that the various types of spectra represent different stages of stellar evolution, but there are divergences of opinion as to the exact order in which the various types should follow each other. Dr. Vogel still holds, with some slight modifications, to the classification which he suggested in 1874, and believes that all the stars can be arranged along a descending line of temperature. Sir Norman Lockyer, who has adopted the same method of work as Prof. Pickering, and has also obtained large-scale photographs of stellar spectra, finds evidence that there are some stars which are getting hotter while others are becoming cooler, so that two series of spectra can be recognised.

For the Draper Catalogue a somewhat arbitrary and provisional classification was adopted, but this has not been found sufficient to meet the requirements of the more detailed results which are now available.

Among the stars with line spectra, as previous researches have shown, there are a few sets of lines which occur with various relative intensities in different stars, each set in some degree varying bodily, and the new classification is based chiefly upon the distribution of these sets. As will appear later, the classification adopted by Miss Maury also takes account of the appearance, as well as of the positions of spectral lines, and every care has been taken to eliminate instrumental sources of error.

Four distinct sets of lines are distinguished. The first includes the lines of hydrogen and calcium, and the remainder are thus described:—

"Another class of lines frequently mentioned comprises those which are characteristic of the solar spectrum, excluding the lines of hydrogen and calcium. They are called 'solar' lines, except when referring to lines not contained in the solar spectrum, in which case they are called metallic lines."

"A third class of lines includes those known as 'Orion lines,' from the fact that they are conspicuous in the spectra of many stars belonging to the constellation Orion. . . .

"Certain stars, such as α Cygni and δ Canis Majoris, have spectra in which the majority of the lines, though probably identical in position with lines belonging to the solar spectrum, differ greatly in intensity, while others apparently are not represented in the solar spectrum. The characteristic lines of such stars should perhaps be regarded as forming a class distinct from those already described."

Bearing in mind these different classes of lines, the new system of classification can readily be understood. Excluding "composite" spectra and bright line stars, "the stars were arranged in an apparently progressive series, which in the present case was made to include twenty-two groups. . . . But it also appeared that a single series was inadequate to represent the peculiarities which presented themselves in certain cases, and that it would be more satisfactory to assume the existence of collateral series."

Three lines of progression are recognised in the earlier stages, and are called "divisions." Stars of division *a* are characterised by lines having the appearance with which we are familiar in the solar spectrum; that is, they are fine and sharp, if hydrogen and calcium be excluded. Those of division *b* are uniformly hazy, as in α Aquilæ, but otherwise present no notable differences in relative intensity from corresponding lines which are sharp in division *a*, so that "there appears to be no decided difference in the constitution of the stars belonging respectively to the two divisions." In division *c* the hydrogen lines are narrow and sharp and less intense than in the other divisions, while several lines, some of which do not correspond with solar lines, are of unusually great intensity; these are especially marked in α Cygni.

Groups and divisions alike proceed by very gradual stages in some parts of the series, and it has frequently been found difficult to assign some of the stars their proper places.

In consequence of the adoption of the term "group," which has been in use for the last ten years in connection with Sir Norman Lockyer's classification, some confusion may possibly occur, as similarly numbered groups include different stars. To avoid ambiguity, it will therefore be necessary, in the case of the first seven groups at least, to specify the system of classification in question. In what follows, the Draper groups will be distinguished by the addition of the letter D to the number where necessary.

Of the twenty-two groups, the first five include stars in which the Orion lines are especially marked; the sixth contains stars intermediate between this type and the first type of Secchi, to which belong the stars in the seventh to the eleventh groups inclusive. The twelfth group is intermediate between Secchi's first and second types, and the stars included in groups thirteen to sixteen are of Secchi's second type. Groups seventeen to twenty inclusive correspond to Secchi's third type, and groups twenty-one and twenty-two to the fourth and fifth types respectively. Besides these, two unnumbered groups are recognised, one containing composite spectra, apparently resolvable into two or more, and the other including stars of the Orion type which also show bright lines. Nebulæ find no place among the numbered groups, but reference is made to a former paper (*Ast. Nach.*, vol. 127, p. 1), in which it was suggested that the Wolf Rayet stars probably form a connecting link between the spectra of nebulæ and those of the Orion type.

It is not possible within the limits of this notice to indicate the full details of the twenty-two groups with their sub-divisions, but the general course of development which is suggested may be briefly stated.

In Group I. D, of which ι Orionis is a type, the hydrogen lines are comparatively faint, while the Orion lines are strong, and "solar" lines are absent. Passing to Secchi's first type, through Groups II. D to V. D, the Orion lines become fainter and less numerous until in the spectrum of Sirius (Group VII. D) all but two or three are wanting. Meanwhile solar lines have become numerous, and the hydrogen lines reach their maximum intensity. The transition to succeeding groups is very gradual, hydrogen lines thinning out and solar lines becoming stronger. Arriving at stars like Capella and the sun (Group XIV. D), the intensity of the hydrogen lines is little more than a tenth of that shown in Sirius, and they afterwards continue to decrease, but less rapidly, down to the third type stars (Groups XVII. D to XX. D), where they are inconspicuous. In the third-type stars banded absorption appears, and becomes more marked in each succeeding group, while the majority of the lines fade out in the later groups. An important feature of the series is the manifestation of extensive absorption in the later groups of second type stars and in those of the third type.

For the present, the series is regarded as ending with the spectra of the third type, stars following the twentieth group not being considered as having a place in the series exhibiting the gradual development of stellar spectra.

Spectra of division *c* are not found after the thirteenth group, and those of division *b* disappear still earlier, "so that the series tends to become more uniform as it progresses."

In connection with the new classification, it is remarked (p. 11) that "while it will be generally admitted that the series represents successive stages in stellar evolution, it may still be doubted whether the arrangement beginning with the Orion type, and here adopted, is in fact the natural order. It is strongly indicated, however, by the gradual falling off of the more refrangible rays in the successive groups, by the corresponding increase in the less refrangible rays, and by the occurrence of marked absorption at the close of the series. The comparative simplicity of the Orion spectra and the increasing complexity shown throughout the series, lends additional weight to the argument. Finally, the prevalence of the Orion type in great nebulous regions, as in Orion and the Pleiades, indicates very emphatically that stars of this type are in an early stage of development."

It will be seen that the supposed evolutionary series has been arrived at without reference to temperature considerations. Nevertheless, a gradual reduction of temperature as the series progresses is suggested by the diminishing intensity of the more refrangible rays, so that, in the main series at least, the order is in all probability one of gradually reducing temperature.

As already remarked, the stars of Secchi's fourth type have been omitted from the supposed evolutionary series of spectra, for the reason that the few lines photographed "have not yet been identified with those of other classes of stars, owing to the total dissimilarity of the spectra." This dissimilarity is stated to extend to the yellow part of the spectrum, and is difficult to comprehend in the light of the more recent results obtained by Dr. McClean, who has shown that the spectrum of 152 Schj. contains many lines which are apparently identical with lines in

the spectrum of α Orionis (*Monthly Notices*, vol. lvii. p. 8). The existence of carbon absorption in the solar spectrum, however, is of itself, as Lockyer long ago insisted, a sufficient connecting link between stars resembling the sun and stars in which carbon absorption is predominant. A classification which excludes these stars from the evolutionary series cannot, therefore, be regarded as final.

It is perhaps unfortunate that the new classification was adopted prior to the discovery of terrestrial sources of helium. Many of the "Orion" lines are now known to be due to this gas, but not all of them, so that these lines may be sub-divided into groups. In the preface to the volume Prof. Pickering remarks: "As the investigations were made several years ago, they could not take account of the recent discoveries respecting the spectrum of helium, which, if known at the time, might have had an important influence upon some of the conclusions. Such modifications could not now be introduced without practically rewriting the treatise, which is therefore published without change. A discussion of the relation of the spectra of stars of the Orion type to that of helium has, however, been made, and is contained in the supplementary notes."

The question of classification, however, is not the sole feature of interest possessed by the spectroscopic work at Harvard. Besides this, there are several tables which give the wavelengths of the lines depicted on the photographs, a general catalogue of the spectra, and copious remarks on the spectra of individual stars. In the case of the composite spectra it has been noted that in all but one, o Andromedæ, the spectrum of the earlier type was the fainter. The peculiarities of the spectrum of γ Cassiopeiæ, already recorded by Lockyer (NATURE, vol. li. p. 425), have been fully confirmed, and the additional fact observed that the entire region of the spectrum from λ 4154·7 to 3927·1 appears brighter than the rest of the spectrum, although the brightening is not homogeneous. The possible importance of this feature is suggested by its occurrence also in stars of the first two groups of the new classification.

The complex phenomena in the variable spectrum of β Lyræ are fully detailed, and the composite character of the dark line spectrum detected at Kensington by Sir Norman Lockyer receives independent confirmation. It is concluded that "the bright bands accompany a spectrum approximately of Group IV. D (*e.g.* γ Orionis), which oscillates periodically over one of Group VII. D, division c" (*e.g.* η Leonis), a result which agrees very closely with Lockyer's conclusion that the two dark line stars were not very unlike γ Orionis and β Orionis. It is pointed out that the supposition of a system of three bodies explains most of the spectral phenomena of β Lyræ, but not all of them, and the rapid and complex transformations require to be continuously followed before a complete explanation can be given.

While fully aware of the difficulty attending the satisfactory reproduction of stellar spectra, we think the value of the volume would have been greatly increased by some attempt to give copies of photographs of as many as possible of the typical stars. Without such reproductions the classification can scarcely be adopted by others taking up the work unless photographs of all the typical stars are first obtained. In spite of this drawback, the volume is a magnificent contribution to celestial spectroscopy, and will be of the greatest value to those pursuing similar investigations. Prof. Pickering and his assistants are to be congratulated upon the excellence of this additional contribution to the Henry Draper Memorial. A. FOWLER.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MOST of the arrangements for the approaching meeting of the American Association for the Advancement of Science have now been made, and are announced in the preliminary circular of the local committee. The meeting will be held at Detroit, Michigan, August 9-14. All the meetings, both general and sectional, will be held in the Detroit Central High School.

The chairman of the local committee is General Russell A. Alger, Secretary of War of the United States. The committee contains a great number of distinguished names, including seven or eight presidents of colleges, and several governors, senators, and foreign ministers.

The first session of the American Association, on Monday morning, August 9, will be opened by Prof. Theodore Gill, senior vice-president, owing to the death of President Edward D. Cope. The President-elect, Prof. Wolcott Gibbs, will be introduced, and addresses of welcome will be made by Mayor Maybury and by the ex-Minister to Spain, Mr. Thomas W. Palmer, after which the sections will meet. The addresses by the several vice-presidents of the sections will be as follows:—Prof. Carl Barus, to the section of physics, on long range temperature and pressure variables in physics; by Prof. Wm. J. McGee, to the section of anthropology, on the science of humanity; and by Prof J. C. White, to the section of geology and geography, on the Pittsburg coal bed (the latter to be read in his absence at the Geological Congress at St. Petersburg); Prof. W. W. Beman, to the section of astronomy and mathematics, on a chapter in the history of mathematics; by Mr. Richard T. Colburn, to the section of social and economic science, on improvident civilisation; and by Prof. L. O. Howard (nominated to succeed the late Prof. G. Brown Goode), to the section of zoology, on a subject to be hereafter announced; Prof. W. P. Mason, to the section of chemistry, on sanitary chemistry; by Prof. George F. Atkinson, to the section of botany, on experimental morphology; and by Prof. John Galbraith, to the section of mechanical science and engineering, on applied mechanics.

A general session will be held on the evening of the opening day, and Prof. Theodore Gill will deliver, as the presidential address, a memorial of the life and work of the late president, Prof. Edward D. Cope, after which will follow a reception by the citizens of Detroit.

August 10-13 will be occupied as usual by section meetings, and to some extent by excursions of the sections. A new arrangement has been made by which the affiliated societies will occupy a portion of the time heretofore allotted to the sections; and these meetings will be open to members of the Association, as those of the several sections are to members of the affiliated societies. Only three societies meet this year in connection with the Association, namely, the Geological Society of America, the American Chemical Society, and the Society for the Promotion of Agricultural Science. These several societies meet on August 9-11. The Association of Economic Entomologists anticipates the others, holding its meetings on August 6 and 7. Of the other Societies usually affiliated with the Association, the American Mathematical Society will meet at Toronto on August 17-18; and the Society for the Promotion of Engineering Education on August 16-18.

The closing meeting of the Association will be held on the evening of August 13, followed by a reception.

There will be a general excursion by steamer to St. Claire Flats on August 14, the contemplated trip to Buffalo and Niagara Falls having been abandoned.

Attention is again called to the fact that members of foreign scientific associations of a national character are admitted without fee to the meetings of the American Association.

Matters relating to local arrangements, transportation, &c., are in the hands of the local secretary, Mr. John A. Russell, No. 401 Chamber of Commerce, Detroit, Mich. Hotel and boarding-house accommodation is arranged by Mr. Edward W. Pendleton, of the same address. Nominations to membership and letters relating to the general business of the Association should be sent to Miss C. A. Watson, assistant secretary, Salem, Mass., until August 3; after that date to the American Association, Detroit, Mich.

The circular repeats the announcement that after the close of the meeting it is expected that members of the American Association will go in a body to Toronto to join in welcoming the British Association to America. Special rates of fare will probably be secured for this purpose.

The several sections will issue preliminary circulars. The first to appear is that of the anthropological section, which states that Tuesday, August 10, will be devoted to folklore, to which the American Folklore Society has been invited. On Wednesday the report of the committee on the ethnography of the white race in America will be presented in the morning, to be followed by discussion; the subject of psychology will occupy the afternoon. Thursday forenoon will be devoted to the archæology and ethnology of Mexico and Central America; afternoon, to the United States. On Friday morning the report of the committee on anthropologic teaching will be received; and in the afternoon the subject for consideration will be somatology.

THE ANALYSIS OF PHONOGRAPH RECORDS.[1]

AFTER describing the general characters of waves, as regards pitch, amplitude, and form, Dr. McKendrick said :—

Thus we can now understand what is meant by a compound wave, and you will appreciate the statement that compound waves may be very complex in character. If you look at the curves showing the resultant waves, you will see that they represent, in a way, the character of the variations of pressure made on the drum-head. With simple pendular waves, the drum-head moves out and in with perfect regularity, like the movements of a pendulum. The physiological effect of such simple pendular vibrations is a sensation of a pure tone, such as you hear when I bow this tuning-fork. But if a compound wave falls on the drum-head, it is not so easy to follow with the imagination the variations of pressure. While these variations occur in regularly recurring intervals of time so as to give the sensation of the pitch of the fundamental tone, the movement may not be uniform on each side of the median line, indicating the position of repose of the drum-head, like the swing of a pendulum. Thus the drum-head may move in, owing to the increase of pressure, faster than it moves out, or the reverse; or it may move in a little distance, then return again to the starting-point and again move in, and it may return to the position of rest after one or more to-and-fro movements Again, it may be pushed in to the maximum distance, and remain in that position for a short time, and then return to the original place of repose. Thus the characters of the variations of pressure may vary to a remarkable degree—to a degree, with a very complex sound, that is to us almost inconceivable; but we may be sure that these variations of pressure will be faithfully followed by the drum-head, and communicated by it to the deeper ear. When a compound wave thus falls on the ear, the result is a sensation of sound of a certain quality, or timbre, or clang, and we say that we hear the sound of various musical instruments, as in a brass band or an orchestra, or the sound of a particular instrument, a trombone, a flute, a harp, a clarionet, or the sound of a well-known voice that we can distinguish from all others.

He then described the attempts to record graphically the vibrations of bodies emitting sound from the time of Thomas Young down to 1874-75, when the phonograph was invented. In 1878, Fleeming Jenkin and Ewing succeeded in obtaining tracings of the records of vowel sounds on the tinfoil phonograph, and the curves were submitted to harmonic analysis. Since that time, the marks on the tinfoil of the first phonograph have been scrutinised by Grutzner, Mayer, Graham Bell, Preece, and Lahr. The imperfections of the tinfoil phonograph made progress impossible for ten years (from 1878 to 1888), during which time, however, Edison, Graham Bell, and others were engaged in working out the mechanical details of the wax-cylinder phonograph. The subject was then taken up by Hermann, and he succeeded in obtaining photographs of the vibrations of the vowel sounds, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. The curves thus obtained were very beautiful. In 1891, Boeke, in a laborious microscopical research, measured the transverse diameters of the depressions on the wax cylinder at different depths, and from these measurements calculated the depths of the curves. He then reconstructed the curves on a large scale, and he also has been busily engaged in the analysis of vowel curves.

Recently also Pipping has traced and analysed the curves obtained by a kind of phonautograph constructed on the type of the drum-head of the ear, and R. J. Lloyd has written two valuable papers on the interpretation of the tracings obtained by Pipping and by Hermann.

Dr. McKendrick exhibited one of the first phonographs made in this country. It was constructed by the late Prof. Fleeming Jenkin in 1876. It represents the instrument in its simplest form. You observe how the drum travels from side to side as in the phonautograph. The drum has a deep spiral groove, the thread of which corresponds to that of the spindle on which the drum rotates, and it is covered with thin, soft tinfoil. The membrane has fixed firmly to its centre a stout little marker having a chisel-shaped edge. When sound waves fall on the membrane it vibrates, and as the drum is rotated, the edge of the needle pushes in the tinfoil into the spiral groove, and it makes a series of indentations corresponding to the variations of pressures produced by the sound waves. When the sound is reproduced, we run the point of the needle over these indentations by turning the drum, and the varying pressures on the needle point caused by the indentations act on the membrane, and reproduce the sound. Thus this simple mechanism records the *number* of vibrations, corresponding to pitch, the relative *amplitude* of the vibrations, corresponding to intensity or loudness, and the *form* of the vibrations which has reference to the quality of the sound.

Since this remarkable invention first appeared, the phonograph has been improved so as to make it now a valuable scientific instrument. Many are too apt to think of it as an amusing toy, or as an apparatus that will serve the practical purpose of a shorthand writer. It is both amusing and practical, but it is much more. It is now a scientific instrument worthy of a place in physical and physiological laboratories beside other instruments of scientific research, and those employed for demonstration in teaching. It merits this position because it makes it possible to study some of the phenomena of sound in a manner otherwise unattainable.

Since 1877 the phonograph has been immensely improved, and we now have it in the form that you see before you. The machine used in this country is so geared that the wax cylinder, 6⅝ inches in circumference, makes two revolutions in one second, while the spiral grooves described on the cylinder are 1/200 inch apart. A spiral line about 136 yards in length may be described on the cylinder, and the recording or reproducing point travels over this distance in about six minutes.

I have also used the American model, now also before you, which resembles in all essential particulars the one I have just described, except that the grooves are 1/100 inch apart, instead of 1/200 inch.

The mechanism by which the glass disc or diaphragm communicates its movement is shown by means of the large model now before you. When sound waves fall on the glass disc, the latter is subjected to variations of pressure, as I have already explained. From the centre of the glass disc there comes a rod which passes to the end of a lever, and to this lever a counterpoise is attached. The end of the lever carries a sapphire point which, like a gouge, cuts a spiral groove on the surface of the wax cylinder. When there is increased pressure on the disc, the inclination of the edge of the gouge is directed downwards at such an angle with the surface of the wax cylinder as to cut a groove of a certain depth; but when the pressure becomes less, the angle is changed, the gouge cuts more in a horizontal direction, and the groove ploughed out is not so deep. Consequently as with each vibration of sound we have, as I have already explained, increased pressure and diminished pressure, a series of marks of an oblong form are made in the bottom of the groove, each little mark corresponding to a vibration. The number of such marks, therefore, in a given distance—which, when the velocity of the movement is taken into account, represents a certain interval of time, say the one-fiftieth of a second—corresponds to the pitch of the note; the depth of the marks corresponds to the intensity of the vibration; and the form of the marks to the form of the vibration. Again, suppose a note is sung *diminuendo* to *crescendo*, and again to *diminuendo*, the depth of the groove will vary according to the intensity, at first shallow, gradually becoming deeper till the maximum depth has been reached, and again becoming more and more shallow. These marks, therefore, on the wax cylinder are the representations of the mechanical effects of the vibrations in all respects—number (pitch), depth (intensity or loudness), form (quality). It will be evident, therefore, that if we run over these marks again with the reproducing point, the glass disc will again vibrate to the impulses received by the ups and downs on the cylinder as to reproduce faithfully, but with diminished intensity, the original sound. It is, therefore, an investigation of great interest to study these marks, to reproduce them on such a scale as to enable us to study their form, and to let us see the ups and downs as we would do, suppose we could make a longitudinal section along the bottom of the groove, and looked at the marks sideways.

Before we set ourselves to the study of these marks, let me bring under your notice certain other branches of the investigation. In the first place, we may, to a wonderful extent, increase the volume of tone or loudness of the phonograph by the use of

[1] Abstract of the Science Lecture for 1896, delivered to the Philosophical Society of Glasgow on December 16, 1896, by John G. McKendrick, M.D., F.R.S., Professor of Physiology, University of Glasgow.

resonators. No doubt the *quality* of the tones is best appreciated by carrying the vibrations directly to the vicinity of the drum-head of the ear, as is usually done, by fine tubes; but this method is not always agreeable, and the pleasurable effect is sadly marred by the friction noises. Still the fact that tones are heard best in this way, *as regards their quality*, proves to my mind that the marks on the wax cylinder are accurate representations of the varying intensities of the pressures caused by the sound waves. Resonators, such as the large one you now see, increase the volume of tone, and you will notice how accurately the tones are reproduced.

Now, let us see what we can make of the marks. I have endeavoured to study the marks on the wax cylinder in three different ways—by casts, by photographs, and by mechanical devices.

As regards the first method—taking casts, which was also attempted by Hermann and Boeke—the results were not satisfactory. The most efficient method followed by me was to paint in the cylinder, with a camel-hair brush, a layer of celloidin dissolved in ether. This soon hardened, and the film could then be peeled off. The thin film thus obtained was then inverted on the stage of a microscope, and the marks were seen in relief. A photograph of the marks thus obtained is now on the screen (Fig. 1).

The depressions are well seen, and their differences as regards length are obvious. The method has the disadvantage of flattening out the marks.

I took numerous photographs, with the aid of the microscope and camera, of portions of the surface of the cylinder on which were records of many instruments and of the voice. I now show you on the screen examples of such records (Fig. 2).

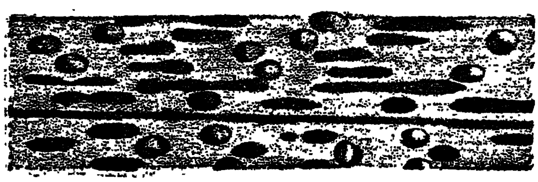

Fig. 1.—Celloidin cast (magnified) of marks on wax cylinder. Portion of record of a military band.

Each figure, from above downwards, represents the $\frac{1}{5}$th of an inch on the surface of the wax magnified fourteen diameters. The grooves seen in each figure are, on the wax cylinder, $\frac{1}{200}$th inch apart, and the length of the groove, from above downwards, represents in time the $\frac{1}{64}$th second—that is to say, when each tracing was recorded, the sapphire point of the recorder travelled over the distance represented in magnified proportions in the $\frac{1}{64}$th part of a second. By counting the number of indentations or marks, which in a photograph have a curious appearance of being in relief, one can at once determine approximately the pitch of the tone, the vibrations of which make the impression. The tones highest in pitch were obtained from the piccolo and the xylophone. Here the pitch was about 1920 vibrations per second. In Fig. *A* we have a picture of the vibrations produced by the tones of the violin, and it will be seen that they vary in character. Sometimes the marks are a little apart, and at other times they blend into each other, the mark widening out as the receding point cut into the wax and then contracting as it receded. It is to be borne in mind that even when the glass disc is not vibrating, the recorder ploughs a groove on the cylinder, and when the glass disc vibrates each vibration cuts deeper into the groove. The figure of the vibration of the tones of a flute (*B*) shows moniliform markings, indicating that the disc may not, in some instances, return to its position of rest for a short time. Sometimes the intensity of the tone is so great as to cause, after each deeply ploughed groove (as will be seen in the figure of the vibrations of the tones of an organ, *D*), a rebound lifting the recorder up to the surface of the cylinder, or even off the surface altogether. This is the explanation of the smooth spaces between the ends of the individual marks.

To obtain a mechanical representation of the curves is a very difficult matter. The difficulties were so far overcome by the device of Jenkin and Ewing with the tinfoil phonograph. The method followed by these observers, which was entirely mechanical, was to cause the disc of the phonograph to record its movements on a drum moved at the same rate as that of the cylinder. As I have already mentioned, Hermann photographed the oscillations of a beam of light reflected from a small mirror connected with the disc of the phonograph, the whole apparatus moving slowly. My method consists in the adaptation of a light lever to the phonograph itself, and so arranged that it (the point of the marker) would travel over all the ups and downs of the phonographic curve on the wax cylinder at an extremely slow rate. The obvious objection to any method of directly recording the ups and downs of the lever is that the inertia of the lever might cause extraneous vibrations, while, at the same time, the smaller marks on the wax cylinder might be missed. These objections, however, were removed by reducing the friction to minimum, and by moving the phonograph cylinder so slowly as to make the movement almost invisible to the naked eye. In this way inertia ceases to give trouble. The first arrangement gave curves of very small amplitude, a specimen of which I now show you.

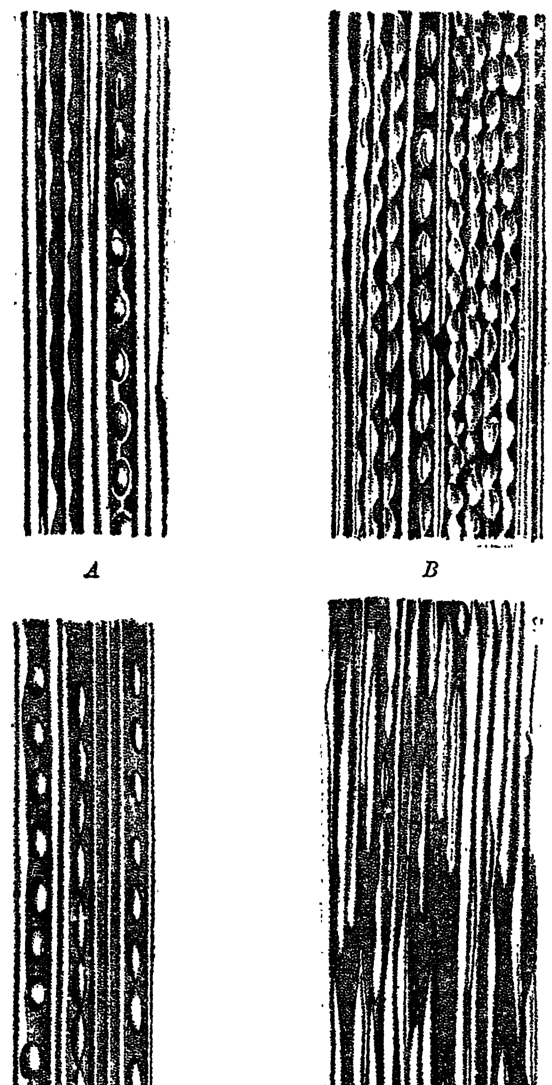

Fig. 2.—From photographs of portions of the surface of the wax cylinder. *A*, violin. *B*, flute. *C*, vowel *o*. *D*, full organ.

Various mechanical arrangements were employed, some of which I described to the Royal Society of Edinburgh in February last.

My attention has since been directed to perfecting a mechanism for obtaining a record of the vibrations.

The instrument now before you, which I shall call a *phonograph-recorder*, traces out, on a large scale, the curves of the indentations on the wax cylinder corresponding to each vibration of sound, and it does so in a way that seems to be highly satisfactory.[1]

Since the apparatus was brought to its present condition, I have been able to record the vibrations of the tones of several instruments, and also the tones of the human voice, both in singing and in speech. Illustrations of these I now show you (Fig. 3).

First, with reference to speech, I wish to point out that when the record of a *word* is examined it is found to consist of a long series of waves, the number of which depends (1) on the pitch of the vowel constituents in the word, and (2) on the duration of the whole word or of its syllables individually. There is not for each word a definite wave form, but a vast series of waves, and, even although the greatest care be taken, it is impossible to obtain two records for the same word precisely the same in character. A word is built up of a succession of sounds, all usually of a musical character. Each of these sounds, if taken individually, is represented on the phonograph-record by a greater or less number of waves or vibrations, according to the pitch of the sound and its duration. The pitch, of course, will depend on the number of vibrations per second, or per hundredth of a second, according to the standard we take, but the number of the waves counted depends on the duration of the sound. As it is almost impossible to utter the same sound twice over in exactly the same fraction of a second, or in the same interval of time, the number of waves counted varies much in different records. The rate per unit of time determines the pitch, the number the duration of the sound. In a *word*, these successive sounds blend into each other, and, in many records, the passage from one pitch to another can be distinctly seen. The speech sounds of a man vary in pitch from 100 to 150 vibrations per second, and the song sounds of a man from 80 to 400 vibrations per second. The sounds that build up a word are chiefly those of the vowels. These give a series of waves representing a variation in pitch according to the character of the vowel sound. In the record of a spoken word the pitch is constantly moving up and down, so the waves are seen in the record to change in length. It is also very difficult to notice where one series of waves ends and where another begins. For example, in the word *Con-stan-ti-nople*, the predominant sounds are those of *o-a-i-o-ill*, and the variation in pitch is observable to the ear if, in *speaking* the word, we allow the sound of the syllables to be prolonged. If we look at the record of the word, we find these variations in pitch indicated by the rate of the waves, or, as the eye may catch this more easily, by the greater or less length of wave, according to the pitch of the sound. The consonantal sounds of the word are breaks, as it were, in the stream of air issuing from the oral cavity, and these breaks (I am not discussing the mechanism at present) produce sounds that have also often the character of vowel sounds. Thus, at the beginning of "Constantinople," we have, as will be observed on pronouncing the syllables very slowly, the sound *ŭkkō*. This sound is represented in the record by a series of waves. Then follow the waves of the vowel *o*. Next we have the sound *nn* (sound through the nose), also represented by a series of waves. Next the hissing sound *ss*, which has first something in it of the vowel *e* or *i*, and then the *iss-s*. This sound also is shown by a series of waves. Then there is *ta*, which has a double series of waves—(1) those for *it* or *t*, and the next for *a*. This passes into the prolonged vowel *a*, this into *in*, this followed by *ti* passing into the vowel *i*, then another *in*, then a long *o*, then a sound like *op*, and, lastly, the sound *ill*, a sort of double-vowel sound. As so many of these sounds have the character of vowels, it is impossible, by an inspection of the record, to say where one set of waves begins and another ends. There are no such breaks corresponding to the consonants; the vibrations of the consonants glide on as smoothly as those of the vowels. The *number* of waves producing a word is sometimes enormous. In "Constantinople" there may be 500, or 600, or 800 vibrations. A record of the words "Royal Society of Edinburgh," spoken with the slowness of ordinary speech, showed over 3000 vibrations, and I am not sure if they were all counted. This brief illustration gives one an insight into nature's method of producing speech sounds, and it shows clearly that we can never hope to reach such records in the sense of identifying the curve by an inspection of the vibrations. The details are too minute to be of service to us, and we must again fall back on the power the ear possesses of identifying the sounds, and on the use of conventional signs or symbols, such as letters of the alphabet, vowel symbols, consonant symbols, or the symbols of Chinese, which are monosyllabic roots often meaning very different things, according to the inflection of tone, the variations in pitch being used in that language to convey shades of meaning.

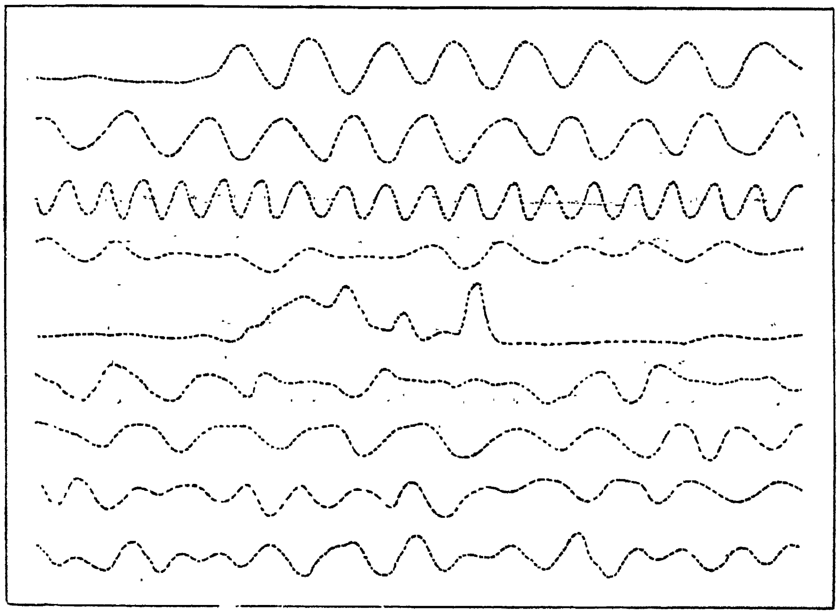

FIG. 3.—Specimens of curves obtained by phonograph recorder. Four inches = 1/120th sec. The curves read from left to right. The lower curve of the flute is continuous with the upper one, to show change of pitch. These curves are given to show the great variety of wave form. They are not sufficiently accurate for analysis. To obtain curves suitable for analysis, the greatest care must be taken.

[1] For a diagram of the apparatus, see *Proc. Roy. Soc. Ed.*, December 7, 1896.

When human voice sounds are produced in singing, especially when an open vowel sound is sung on a note of definite pitch, the record is much more easily understood. Then we have the waves following each other with great regularity, and the pitch can easily be made out. Still, as has been well pointed out by Dr. R. J. Lloyd, of Liverpool, a gentleman who has devoted much time and learning to this subject, it is impossible by a visual inspection of the vowel curve to recognise its elements. Thus two curves, very similar, possibly identical to the eye, may give different sounds to the ear—that is to say, the ear, or ear and brain together, have analytical powers of the finest delicacy. No doubt, by the application of the Fourierian analysis, we may split up the periodic wave into a fundamental of the same period, and a series of waves of varying strength vibrating 2, 3, 4, 5, &c., times faster than the fundamental, and the relative amplitude of each of these may be determined. If all these waves of given amplitude and given phase acted simultaneously on a given particle, the particle would describe the vibration as seen in the original curve. Dr. Lloyd, however, is of opinion that even a Fourierian analysis may not exhaust the contents of a vowel, as it does not take account of inharmonic constituents which may possibly exist. Hermann and Pipping have also been investigating the analysis of vowel tones, and their investigations have revealed many difficulties. Hermann experimented with the ordinary phonograph, and obtained photographs of the movements of the vibrating glass plate. Pipping's curves were not obtained from the phonograph, but from the vibrations of a minute membrane made to represent the drum-head of the ear. His curves show large periodic waves with minute waves on their summits, and they suggest that the large waves may be vibrations due to the membrane itself. I therefore think that argument as to the character of vowels should be based only on records obtained from the phonograph itself, which is furnished with a vibrator that will not record its own periodic vibrations unless the sound be remarkably intense. In ordinary voice production and in ordinary singing, the vibrator of the phonograph faithfully records only the pressures falling upon it—no more and no less.

I shall now show you another method of recording, not the individual vibrations of the phonograph, but the variations in intensity of the sounds of the phonograph—the intensities of individual notes and chords. I was led to use this method by becoming acquainted with an instrument devised by Prof. Heurthle, of Breslau. He has succeeded in recording the vibrations of the sounds of the heart. I saw that his instrument was very useful, and I adapted it to the particular purpose in hand. Heurthle's instrument is an electro-magnet acting on a metal plate connected with the elastic membrane of a tambour. Another drum is connected with the first by an india-rubber tube. The metal plate of the first tambour is pulled down by the electro-magnet; thus the air is rarefied in the tube and in both tambours, and the lever of the second tambour moves. The next instant the lever flies back. We shall now connect Graham's variable resistance apparatus with the phonograph. As sound waves fall on it, a change is produced in the current passing through the electro-magnet; the latter acts on its tambour; a variable pressure is communicated to the other tambour; and if the lever of the latter is brought against a revolving drum, a tracing is obtained. I show you a little bit of such a tracing (Fig. 4).

Each note and each chord is recorded, so that you get a mechanical tracing of the variations of intensity. Now this experiment suggested another of a different kind. Suppose I send the current not only through the variable resistance apparatus above the disc of the phonograph, but also through the primary coil of an induction machine. The wires from the secondary coil pass to two platinum plates dipped in weak salt solution. I now set the phonograph going; and when I put my fingers into the beakers containing salt solution, I *feel* the intensity of every note. The variation of intensity, the time, the rhythm, and even the expression of music, are all felt. I shall now place on the mandril of the phonograph a cylinder on which has been recorded another piece of music, with a faster *tempo*. I now feel a series of electrical thrills corresponding to every variation of intensity of sound coming from the phonograph. That method shows that the nerves of the skin can be stimulated by irritations coming to it at the rate of the notes and chords of rapid music. Some of the notes produced by the phonograph do not last longer than the five-hundredth or six-hundredth part of a second, but they are quite sufficient to stimulate the nerves of the skin, and, as I have pointed out, you can appreciate the variations of intensity. You can *feel* the long drawn-out notes from the saxhorn or trombone. You feel the *crescendo* and *diminuendo* of rhythmic movement, and you can estimate the duration of the note and chord. You feel even something of the expression of the music. It is rather a pity to say than even expression is mechanical. It is undoubtedly mechanical when you deal with the records of the phonograph. A number of interesting questions of a physiological nature are suggested by this experiment. The skin is not a structure that can analyse tone or distinguish pitch; it cannot tell you the number of vibrations, although there is a curious approach to it. While it is not by any means accurate, you can distinguish tones of low pitch—very low tones—by a feeling of "intermission." Experimenting in this way, you may stimulate by interrupting this circuit at the rate of 30 or 40 or 50 breaks per second, and yet the skin will tell you the individual breaks; but when you get above that number you lose the consciousness of the individual breaks, and you have a more or less continuous sensation. The phonograph does not necessarily give you 50 or 60 *stimuli* to produce a sensation of a tone; you do not require that number. I found that 8 or 10 per second may give you the sensation for a tone of any pitch. In the same way you may be able to notice a slight difference up to perhaps 50 or 60, but above that the sensation seems continuous. It is not the number of *stimuli* that determine pitch, but the rate at which the *stimuli* affect the sense organ, whether it be ear or skin. Then the question arises, What is it in the skin that is irritated? It is not the corpuscles. They have to do with pressure. There is no organ for the sense of temperature. You may say that the feeling is muscular. Possibly it may be so; but the effect is most marked when the current is so weak as to make it unlikely that it passes so deep as to reach the muscles.

This experiment suggests the possibility of being able to communicate to those who are stone deaf the feeling, or, at all events, the rhythm of music. It is not music, of course, but, if you like to call it so, it is music *on one plane and without colour*. There is no appreciation of pitch or colour or of quality, and there is no effort at analysis, an effort which, I believe, has a great deal to do with the pleasurable sensation we derive from music. In this experiment you have the rhythm which enters largely into musical feeling. Recently, through the kindness of Dr. J. Kerr Love, I had the opportunity of experimenting with four patients from the Deaf and Dumb Institution, one of whom had her hearing till she was eleven years of

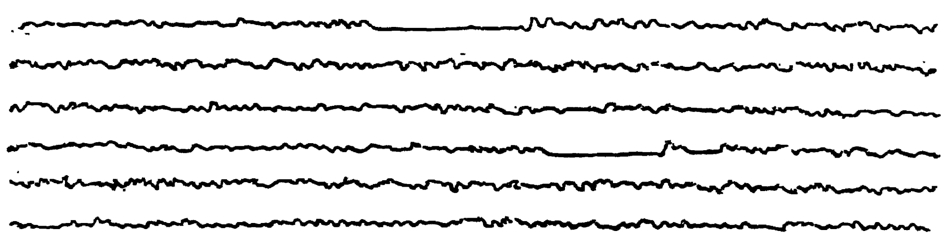

FIG. 4.—Portion of a record of the time and intensity of music played by a military band. Each curve represents a note or chord. The curves are read from right to left. The cylinder in which the record was taken was moving slowly, about 1 inch per second.

age, and then she became stone deaf. This girl had undoubtedly a recollection of music, although she does not now hear any sound. She wrote me a little letter, in which she declared that *what she felt was music*, and that it awakened in her mind a conscious something that recalled what music was. The others had no conception of music, but they were able to appreciate the rhythm, and it was interesting to notice how they all, without exception, caught up the rhythm, and bobbed their heads up and down, keeping time with the electrical thrills in their finger-tips.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The establishment of a University Lectureship in Experimental Psychology was opposed in the Senate, but it has now been carried by a very large majority.

Thirty-three men and three women have obtained a first-class in the Natural Sciences Tripos, Part I. In Part II. the first-class includes eleven names.

Prof. Allbutt, F.R.S., has been appointed to represent the University at the International Medical Congress to be held at Moscow in August.

The Harkness Scholarship in Geology and Palæontology has been awarded to Mr. R. H. Kitson, of Trinity College.

The Observatory Syndicate report that, Mr. Newall's term of office as Observer having expired, he has generously undertaken to continue to give his services without stipend for another term of five years. They think, however, that the provision of a stipend for the Newall Observer is an urgent claim on the funds of the University. In its present impoverished state the University is much indebted to Mr. Newall for his devoted and efficient aid in the department of physical astronomy. The portion of the catalogue of the *Astronomische Gesellschaft* allotted to Cambridge has now been published, after twenty-five years' work carried out for the most part by Mr. A. Graham. It refers to the zone 25° to 30°, and contains the places of 14,464 stars, obtained from about 47,570 observations. A new photographic telescope is being made for the observatory by Sir Howard Grubb, and the building for its accommodation will be taken in hand this summer.

The Special Board for Physics and Chemistry have, as was anticipated, withdrawn their proposals that the laboratory note-books of candidates for the first part of the National Sciences Tripos should be submitted to the examiners. They adhere to the proposal, in a modified form, as regards the second part of the examination. It is, however, provided that no marks shall be assigned for the note-books, the inspection of which is intended simply to give some guidance to the examiners in estimating the value of the practical part of the examination.

The first dissertations offered by advanced (post-graduate) students as candidates for the B.A. degree have been submitted and approved. Mr. J. S. E. Townsend and Mr. E. Rutherford have each offered memoirs on electrical subjects which have been honoured by publication in the *Phil. Trans.* of the Royal Society, and the Degree Committee record their opinion that the work submitted "is of distinction as a record of original research." These gentlemen have accordingly received the University Certificate of Research, and the degree of Bachelor of Arts, under the new regulations for graduates of other Universities.

The Hutchinson Studentship has been awarded to Mr. V. H. Blackman, of St. John's College, for botanical researches on Algæ. The Hockin Prize for Electricity has been awarded to Mr. W. A. D. Rudge, of the same college, a student in his first year.

THE University of Dublin has conferred the honorary degree of Doctor of Science upon Dr. Wilhelm His, Professor of Anatomy in Leipzig University, and Prof. Ramsay.

THE will of the late Mr. J. H. R. Molson has been admitted to probate at Montreal. It assigns 100,000 dollars to McGill University, 30,000 dollars to the Frazer Institute, and 10,000 dollars to Bishop's College School at Lennoxville.

ON Thursday last a farewell address was presented to Prof. Sollas, F.R.S., by past and present students of geology in Trinity College, Dublin. Prof. Sollas is leaving Dublin for Oxford, where he succeeds the late Prof. Green as professor of geology.

ENDOWMENTS recently received by Rutgers College increase the fund nearly 50,000 dollars, and include 5000 dollars from the Vice-President of the United States; 10,000 from Mrs. Winants, of Brooklyn; 5000 each from Mr. Frederick Frelinghuysen, of Newark, and Mr. Samuel Sloan and Mr. Richard Schlett, of New York, with the promise of 10,000 more from the latter; and 3234 from the Alumni Association.

IN order to obtain an accurate conception of the growth of Harvard University, Prof. C. S. Minot has compiled a table showing the gifts of money to Harvard College from 1868 to 1896, and he makes it the subject of a contribution to the Harvard *Graduate's Magazine* for June. It appears from this article that Harvard University has received annually during the past twenty-eight years in round numbers 330,000 dollars. The educational efficiency of the University has increased even faster than its endowment. It is held that seven scientific departments, in which the Medical, Dental, and Veterinary Schools have a common interest, need immediate endowment. The departments are: (1) anatomy (human and comparative); (2) physiology; (3) histology and embryology; (4) pathology; (5) bacteriology; (6) pharmacology; (7) hygiene. Each of the seven departments needs to be organised on the minimum basis of 300,000 dollars, making in all an endowment of 2,100,000 dollars. If the gifts continue as heretofore, six years would suffice to furnish the required amount. It is suggested that the development of the seven departments mentioned would be facilitated by the consolidation of the Medical, Dental, and Veterinary Schools under a single Faculty.

THE following are among recent appointments:—Mr. J. R. Campbell, of the Glasgow Technical College, to be lecturer in agriculture at the Harris Institute, Preston; Prof. W. T. Engelmann, of Utrecht, to succeed the late Prof. Du Bois Reymond in the chair of physiology in the University of Berlin; Dr. W. B. Pillsbury to be instructor in psychology in the University of Michigan; Dr. C. E. Seashore to be assistant in psychology in the University of Iowa; Mr. S. I. Franz to be assistant in psychology in Columbia University; Prof. William S. Franklin to be professor of physics and electrical engineering at Lehigh University; Dr. John Marshall to be professor of chemistry in the medical department of the University of Pennsylvania; Miss Bertha Stoneman to be professor of botany in the Huguenot College for Women in Cape Colony; Prof. J. L. Prevost to be professor of physiology in the University of Geneva; Dr. P. Francotte to be professor of embryology and Dr. P. Stroobant professor of astronomy in the University of Brussels; Dr. J. J. Zumstein to be professor of anatomy in the University of Marburg; Dr. Fuchs, privat-docent in palæontology and director of the geological section of the Natural History Museum at Munich, to be assistant professor; Dr. H. Baum, prosector and privat-docent in osteology at the Dresden Technical High School, to be professor; Dr. W. Ule, privat-docent in geography at Halle, to be professor; Dr. J. J. Ptaschicky to be professor of geometry at St. Petersburg; Dr. A. O. Kihlman to be assistant professor of botany at Helsingfors; Dr. Heim to be assistant professor of hygiene at Erlangen; Dr. Alex. Bittner to be chief geologist of the K. K. geologischen Reichsanstalt at Vienna; also, at the same institution, G. Geyer to be geologist, G. v. Bukowski and August Rosiwal to be adjunkten, and Dr. J. Dreger, F. Eichleiter, Dr. F. v. Kerner, and Dr. J. J. Jahn to be assistants.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 25.—Mr. Shelford Bidwell, President, in the chair.—A paper by Mr. Sutherland, on a new theory of the earth's magnetism, was taken as read.—Dr. Kuenen described some experiments on critical phenomena, made in continuation of a research on the condensation and critical phenomena of mixtures of ethane and nitrous oxide, the results of which were published last year. The author now investigates mixtures of ethane and acetylene, and mixtures of ethane and carbonic acid, and finds for them similar properties to those of the mixtures of ethane and nitrous oxide. The first part of the paper refers to the preparation of ethane, and the effect of impurities on its vapour-pressure, and critical constants.

Ethane from ethyl iodide is not very pure, it has generally several per cent. of an admixture of a substance of higher critical temperature and higher density than ethane; this substance is probably butane. Ethane from sodic acetate, by electrolysis, is nearly pure; the method of preparation is described by the author. The pressure and corresponding volumes during condensation are given for this substance at various temperatures. In the former paper, above referred to, instances are mentioned of mixtures having critical temperatures *below* those of the component substances. The only instance of critical temperatures *above* those of the components, seem to be those relating to mixtures of carbonic acid and acetylene. According to an experiment of Dewar's, however, a mixture of $\frac{1}{2}CO_2$ and $\frac{1}{2}C_2H_2$ has a critical temperature of 41° C., those for carbonic acid and acetylene being 31° and 37° respectively. The present investigation contradicts this result. Dewar may not have taken sufficient precaution in avoiding errors of retardation. Mixtures of carbonic acid and acetylene have critical temperatures between those of the component pure gases. The diagram connecting temperature and volume shows that the plait-point curve is a line with small curvature; the border-curve is relatively narrow. An instance of a critical temperature above those of the components, for this mixture, has not yet been proved. Theory indicates that this phenomenon probably occurs for mixtures having a minimum vapour-pressure at low temperature. Critical temperatures below those of components, seem to occur for mixtures having a maximum vapour-pressure; as for nitrous oxide and ethane. The law connecting the two phenomena is deduced from van der Waal's theory. As a further application of this theory, it is shown that in consequence of certain coincidences between the real border-curve and the hypothethical border-curve, the critical point of the maximum mixture may be determined in exactly the same way as for a single substance. A remark is added with regard to the condensation of such substances as exhibit changes of molecular systems. If an association takes place of molecules to more complicated systems, van der Waal's formula does not apply. Dr. S. P. Thompson asked whether diagrams characteristic of cyanogen had been obtained. Its remarkable polymerism suggested an interesting case for critical phenomena. Dr. Kuenen thought such a substance might be worth investigation.—A paper by Dr. Barton, on the attenuation of electric waves in wires, was taken as read.—Mr. G. F. C. Searle read a paper on the steady motion of an electrified ellipsoid. The first part of the investigation is printed in the *Phil. Trans. Roy. Soc.*; it contains the principles required in the solution of problems with respect to moving electrical charges. The second part, now presented to the Physical Society, deals with the motion of a charged ellipsoid; the treatment is entirely mathematical. When any system of electric charges moves with uniform velocity through the æther, the electro-magnetic field, referred to axes moving forward with the charges, can be completely defined by means of a quantity of which the electric force and the magnetic force are simple functions. Another vector concerned in the problem is the mechanical force experienced by a unit charge moving with the rest of the system. A distribution of electricity on the surface of a charged body such as to give zero distribution at all points inside the surface is an equilibrium distribution. Since the mechanical force vanishes inside the surface, it is shown that on the outside of the surface the mechanical force is perpendicular to the surface, and the above-mentioned function is constant over the surface, and the distribution on an ellipsoid is the same for motion as for rest. When a charged sphere is at rest it produces the same effect as a point-charge at its centre. If the sphere is in motion it produces the same effect as a uniformly-charged line whose length bears to the diameter of the sphere the same ratio as the velocity of the sphere bears to the velocity of light. When the sphere moves with the velocity of light, the line becomes the diameter of the sphere; the same is true for an ellipsoid. At the velocity of light, the charge on any surface is in equilibrium, whatever the distribution. The force between two charges moving with the speed of light, is zero. The lines of electric force for a charged sphere in motion are not radial; they form a series of hyperbolas. The author proceeds to calculate the total energy possessed by an ellipsoid when in motion along its axis of figure. Expressions are given (1) for the energy of a Heaviside ellipsoid; (2) for a sphere; and (3) for a very slender ellipsoid. In all cases the energy becomes infinite when the charges move at the velocity of light. It would seem impossible to make a charged body move at a greater speed than that of light. Prof. Perry said the paper would help to solve many problems connected with the effect of the rotation of the earth upon electrical surface charges. An expression might be found for the mechanical and magnetic forces due to the motion of a charge at any point of the earth's surface. At the equator a point moves at different velocity at midday to its midnight velocity; it may now be possible to determine the magnetic and mechanical effects due to electrical charges at equatorial points. Mr. Blakesley asked whether, in calculating the mutual action of two charged particles, proceeding at the velocity of light, it was assumed that the lines of motion were parallel. Mr. Searle said he had always considered parallel lines of motion; he could not say whether the force would be zero in any other case. The results arrived at in the paper could be applied to problems connected with distributions of terrestrial charges.—The President proposed votes of thanks to the authors; the meeting then adjourned until November.

Chemical Society, June 3.—Prof. Dewar, President, in the chair.—The following papers were read:—On the thermal phenomena attending the change of rotatory power of freshly-prepared solutions of certain carbohydrates; with some remarks on the cause of multirotation, by H. T. Brown and S. Pickering. Freshly prepared solutions of dextrose, lævulose, and milk-sugar contain the sugar as an unstable α-modification, which gradually changes into a stable β-modification; this change is made apparent by a change of specific rotation, and, as the authors show, is accompanied by evolution of heat, the quantity of which has been measured.—On the thermo-chemistry of carbohydrate-hydrolysis: (1) The hydrolysis of starch by vegetable and animal diastase; (2) the hydrolysis of cane-sugar by invertase, by H. T. Brown and S. Pickering. The authors have determined by direct measurement the heat evolved in the hydrolysis of starch by malt-diastase, pancreatic-diastase, Taka-diastase and saliva, and in the hydrolysis of cane-sugar by invertase.—Optical inversion of camphor, by F. S. Kipping and W. J. Pope. It is shown that during the sulphonation of *d*-camphor, part of it is converted into *l*-camphor.—Derivatives of camphoric acid. Part ii. Optically-inactive derivatives, by F. S. Kipping and W. J. Pope.—Racemism and pseudoracemism, by F. S. Kipping and W. J. Pope. The authors show that a number of apparently racemic compounds really consist of intercalations of crystals of the two enantiomorphously related components; the term pseudoracemic is applied to such substances of which several are described in detail.—Note on some new gold salts of the Solanaceous alkaloids, by H. A. D. Jowett. Hyoscine hydrobromide combines with auric chloride and bromide, giving salts of the composition X, HBr, $AuCl_3$ and X, HBr, $AuBr_3$.—Production of camphenol from camphor, by J. E. Marsh and J. A. Gardner. Camphenol, an isomeride of camphor, is obtained by the action of strong sulphuric acid on chlorocamphene, camphene dichloride, and turpentine dihydrochloride.—Preliminary note on the oxidation of fenchene, by J. A. Gardner and G. B. Cockburn. Cis-camphopyric acid is produced on oxidising fenchene with dilute nitric acid.—Apiin and apigenin, by A. G. Perkin. The author produces experimental evidence which renders it probable that apigenin is a hydroxy-derivative of chrysin, the colouring matter of poplar buds.—Rhamnazin, by A. G. Perkin and H. W. Martin.—Experimental verification of van 't Hoff's constant in very dilute solution, by M. Wildermann.—The isomeric dibromoethylenes, by T. Gray. The author has been unsuccessful in his attempts to prepare a stereo-isomeride of ordinary symmetrical dibromoethylene; he considers the latter to be the trans-compound.

Entomological Society, June 2.—Mr. R. Trimen, F.R.S., President, in the chair.—The President referred to the great loss which the Society had sustained by the death of Dr. Fritz Müller, one of its Honorary Fellows, and to his distinguished services in the cause of entomological science, and especially in forwarding the theory of the origin of species.—Dr. Chapman exhibited the larva of *Eriocephala allionella*.—Mr. Jacoby exhibited a fine example of the large Hepialid, *Leto venus*, from Plettenberg Bay, South Africa. The President said that the insect afforded an interesting case of localised distribution, being confined to an area of about fifty by fourteen miles, whereas the larva fed in the wood of *Virgilia capensis*, a common and widely-distributed leguminous tree. The insect was very conspicuous, and could not have been overlooked in other localities.—Mr. Burr showed a pair of gynandromorphous earwigs, *Chelisoches*

morio, Fabr., from Java, with ordinary males and females for comparison. In both specimens the right branch of the forceps was of the male, and the left branch of the female form.—The Hon. Walter Rothschild exhibited a series of specimens of *Eudæmonia brachyura*, Drury, and *E. argiphontes*, Kirby, to show the differences between these two West African Saturniid moths. The distinctness of the latter species had been doubted, as until recently it was only known by the unique examples in the Dublin Museum, and the three published figures of these were materially different from each other. A comparison of the series exhibited showed the two species to be abundantly distinct.—Mr. Kirkaldy exhibited fifty specimens of *Notonecta glauca*, Linn., to show the extreme range in size and colour of this widely-distributed species.—The discussion on mimicry and homœochromatism in butterflies was then resumed by Dr. Dixey, who replied to the comments of Prof. Poulton and Mr. Blandford on his paper. He did not regard the phenomenon of reciprocal convergence as necessarily a demonstrable feature in Müllerian mimicry; it was merely potential. With respect to mimetic Pierinæ, he did not consider that they were invariably protected, but that, in certain cases, they were shown to be so by the indications of convergence exhibited by the models. Mr. Elwes thought, from his personal experience as a collector, that there was too much assumption about both the Batesian and Müllerian theories. In many supposed cases he doubted whether the so-called models were protected by taste or smell. He had previously referred to the extraordinary superficial resemblance between two Pieridæ found in the high Andes of Bolivia, and two others found at similar elevations in Ladak, and was inclined to think that similar conditions of environment produced similar effects. Mr. J. J. Walker, Sir George Hampson, and Colonel Yerbury gave evidence, from personal experience in the Tropics, as to the extreme rarity of butterfly-destruction by birds. The President admitted its rarity in Africa, but stated that he had seen birds, especially the Drongo shrike, chasing butterflies. Mr. Blandford called attention to a recent paper by M. Piepers, who, as the result of twenty-eight years' observation in the Malay region, had seen four instances only of butterflies, two of which belonged to the "protected" genus *Euplœa*, being attacked by birds, and had been driven to the conclusion that the phenomena of mimicry had nothing to do with natural selection.—Papers were communicated by the Rev. F. D. Morice, on new or little-known Sphegidæ from Egypt, and by Prof. J. R. Grote, on changes in the structure of the wing of butterflies.

Geological Society, June 9.—Dr. Henry Hicks, F.R.S., President, in the chair.—The Cretaceous strata of County Antrim, by Dr. W. Fraser Hume. The paper, which dealt with the Irish Cretaceous strata, was divided into four parts, viz.: I. A detailed account of the principal subdivisions, their local distribution, and characteristic fossils. The area occupied by these rocks is separated into five divisions, each marked by special lithological and palæontological features. The main lithological features are displayed in sections between Lisburn and Belfast; they are (1) glauconitic sands (a blue-green rock rich in glauconite); (2) glauconitic marls; (3) yellow sandstones (a light calcareous sandstone); (4) chloritic sands and sandstones of the *Exogyra columba*-zone (yellow-green sands and sandstones); and (5) white limestone. II. Chemical and micromineralogical examination of the lithological types. The glauconitic sands are characterised by the abundance of glauconite (23 per cent. $CaCO_3$), showing evidence of having been formed in the interior of foraminiferal shells; the glauconitic marls by an abundance of spheres and rods of pyrites; the yellow sandstones by a series of heavy minerals, notably rutile, zircon, tourmaline, kyanite, and perfectly-formed crystals of garnet; the *Inoceramus*-zone contains delicate glauconitic mesh-works of hexactinellid sponges and silicified portions of *Inoceramus* and brachiopoda, besides an abundant series of heavy minerals: in the chloritic chalk above the glauconitic sponge-casts become very abundant, associated with delicate casts of foraminifera; the white limestone itself has scarcely any residue. The analyses show that the percentage of carbonate of lime increases steadily from base to summit, the glauconitic marls alone being an exception. III. This section dealt with the stratigraphical conclusions. IV. General questions.—An account of the Portraine inlier, by C. I. Gardiner and S. H. Reynolds.—Some igneous rocks in North Pembrokeshire, by J. Parkinson.

Zoological Society, June 15.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Dr. Arthur Keith exhibited a series of lantern-slides showing the arrangement of the hair and some other points of interest in the Orang-Outang (*Simia satyrus*) that had lately died in the Society's Gardens.—Mr. Oldfield Thomas read an account of the mammals obtained by Mr. John Whitehead during the last three years in the Philippine Islands. During this expedition the peculiar mammal-fauna of the mountains of northern Luzon had been discovered, and Mr. Thomas had already described no less than five new genera and eight new species belonging to it. The paper read contained a detailed account of the whole of Mr. Whitehead's collection.—A communication was read from Prof. T. W. Bridge, on the presence of ribs in *Polyodon* (*Spatularia*) *folium*.—Mr. R. I. Pocock read a paper on the spiders of the suborder *Mygalomorphæ* from the Ethiopian region contained in the collection of the British Museum. Many new genera and species were described, the most interesting being the new genus *Cyclotrematus*, containing two new species collected in Mashonaland by Mr. J. ffolliott Darling, *Stasniopus oculatus*, sp. nov., from Bloemfontein, and *Moggridgea whytei*, sp. nov., obtained by Mr. A. Whyte on the Nyika Plateau. The discovery of new stridulating organs, consisting of modified setæ, lying between the mandible and the maxilla in *Harpactina*, was also alluded to.—A communication was read from Miss Emily M. Sharpe on the butterflies collected in the neigbourhood of Suakim by Mr. Alfred J. Cholmley. Thirty species were enumerated, and the localities where the specimens were collected and the dates of their capture were recorded.—A communication was read from Mr. Walter E. Collinge, describing two new slugs of the genus *Parmarion* from Borneo, viz. *P. everetti* and *P. intermedium*.—A communication was read from Dr. Alphonse Dubois, containing notes on certain specimens of birds in the Brussels Museum, and describing a supposed new species of woodpecker from Borneo, proposed to be called *Tiga borneonensis*.—A communication from Mr. D. J. Scourfield contained some preliminary notes and a report on the Protozoa, Tardigrada, Acarina, and Entomostraca collected by Dr. J. W. Gregory during his expedition to Spitzbergen in 1896.—A communication from Mr. David Bryce contained a report on the Rotifera collected by Dr. Gregory's expedition in Spitzbergen.—Mr. G. A. Boulenger, F.R.S., gave a list of the reptiles and batrachians collected in Northern Nyasaland by Mr. Alex. Whyte, and presented to the British Museum by Sir Harry Johnston, K.C.B. Thirty-six species of reptiles and fifteen species of batrachians were enumerated, of which the following were described as new:—*Lygosoma johnstoni*, *Glypholycus whytii*, *Anthroleptis whytii* and *Hylambates johnstoni*.—Dr. Fowler communicated a paper on the later development of *Arachnactis albida* (M. Sars) and on *A. boweni*, sp. nov., being the third instalment of the "Contributions to our Knowledge of the Plankton of the Faeroe Channel."

Royal Meteorological Society, June 16.—Mr. E. Mawley, President, in the chair.—A paper, by Mr. R. C. Mossman, on the non-instrumental meteorology of London, 1713–1896, was read by the Secretary. The author has gone through the principal meteorological registers and weather records kept in the metropolis, and in this paper discusses for a period of 167 years the notices of thunderstorms, lightning without thunder, fog, snow, hail and gales. The average number of thunderstorms is 9·7 per annum, the maximum occurring in July, and the minimum in February. The average number of fogs is 24·4, and of "dense" fogs 5·8 per annum. The decadal means show that there has been a steady and uninterrupted increase of fog since 1841. The average number of days with snow is 13·6 per annum. The snowiest winter was that of 1887–8, with forty-three days, while in the winter of 1862–3 there is not a single instance of a snowfall. The mean date of first snowfall is November 9, and of last snowfall March 30. Hail is essentially a spring phenomenon, reaching a maximum in March and April; the minimum is in July and August. The average number of days with hail is 5·9 per annum.—Mr. C. Harding gave an account of the hailstorm which occurred in the south-west of London on April 27. This accompanied a thunderstorm, in which the lightning was very vivid. The hail lasted only about twenty minutes, from 6.30 to 6.50 p.m., and in that short space of time the melted hail and rain amounted to about an inch of water. The districts affected by the hail were Tooting, Balham, Streatham, Tulse Hill, and Brixton. The ground was quite white with the hailstones, which in some places remained unmelted the whole of the next day. Much damage was done to fruit-trees and shrubs.

PARIS.

Academy of Sciences, June 21.—M. A. Chatin in the chair.—On the Abelian functions, by M. H. Poincaré.—Expression of the small transverse components of velocity in the gradually varied outflow of liquids, by M. Boussinesq.—Note on the seventh volume of the "Annales de l'observatoire de Bordeaux," by M. Lœwy.—Examination of some spectra, by M. Lecoq de Boisbaudran. A discussion of some points raised by MM. Eder and Valenta on the spectrum of gold.—Note by M. Pomel accompanying the presentation of his work on the "Mammifères quaternaires fossiles algériens, monographie des Porcins."—M. Hatt was nominated a member in the Section of Geography and Navigation, in the place of the late M. d'Abbadie.—On the universal deluge, by M. F. E. Paumier.—On the movement of the perihelia of Mercury and Mars, and of the node of Venus, by M. Simonin.—On the surfaces which can, in several different movements, develop a family of Lamé, by M. Eugène Cosserat.—Observations by M. Darboux on the preceding communication.—On a class of hyperabelian functions, by M. H. Bourget.—On certain equations analogous to differential equations, by M. C. Bourlet.—Observations on the preceding communication, by M. Appell.—On a class of ds^2 of three variables, by M. Levi-Civita.—Application of photography to the measurement of indices of refraction, by MM. Auguste and Louis Lumière. The plate, the refractive index of which is to be measured, is coated very thinly with the sensitive emulsion. It is then faintly illuminated by rays from a point (a minute hole in a sheet of metal). Under these circumstances a halo is produced, arising from reflexion at the back of the plate, the edges of which are quite sharp, and whose diameter determines the refractive index. To apply this method to the measurement of the refractive index of liquids, the back of the plate is wetted with the liquid, and backed with a piece of black velvet soaked in the same. Data are given for water and glycerine.—On a new self-registering apparatus for submarine cables, by M. Ader. The improvements consist of devices for reducing the inertia of the moving parts. The wire carrying the cable current forms part of a minute dynamometer, placed in a powerful magnetic field formed by a permanent magnet. The oscillations are recorded photographically; a practical trial over the Brest-St. Pierre and Marseilles-Algiers cables showed that the number of signals transmitted per minute was from 1·5 to 2·7 times that of the maximum obtainable by the Kelvin recorder.—On a new electrolytic condenser of large capacity and on an electrolytic current rectifier, by M. Ch. Pollak. By passing firstly an alternating current and then a continuous current between aluminium electrodes in an alkaline solution, the plates become coated with an extremely thin crystalline deposit of oxide, which is practically non-conducting. A condenser is thus obtained in which the oxide film acts as the dielectric, and the extreme thinness of this film is the cause of its very high capacity.—Double and triple lines in spectra produced under the influence of an external magnetic field, by M. Zeeman.—On the sulpho-antimonites of potassium, by M. Pouget.—On the fluidity of fused nickel, by M. Jules Garnier.—Combinations of tellurium iodide and bromide with the corresponding hydracids, by M. R. Metzner.—The electrolytic analysis of brass and bronze, by M. Hollard.—The reaction between formaldehyde and potash, by M. Delépine. A thermo-chemical study.—Destruction of organic matter in toxicological researches, by M. A. Villiers. The use of manganese salts with a mixture of hydrochloric and nitric acids is recommended.—On caffotannic acid, by MM. P. Cazeneuve and Haddon.—Coleopterine, a red pigment in the wing shells of some Coleoptera, by M. A. B. Griffiths.—On the decolorisation of wine; new interpretation based upon the function of iron salts, by M. H. Lagatu.—On the subrenal capsules, the renal organs, and lymphoidal tissue of lophobranchial fishes, by M. E. Huot.—On a new Copepod, by M. Émile Brumpt. The new species is found as a parasite of *Polycirrus aurontiacus* (Grube), and is named *Saccopsis Alleni*.—Action of mineral salts upon the development and structure of some graminæ, by M. Ch. Dassonville. The graminaceæ studied, when they were cultivated in pure water, showed a more feeble development in all the tissues, but a much greater lignification.—On the propagation of *Pseudocommis vitis* (Debray), by M. E. Roze.—On the discovery of new strata containing fossils of mammals in the Island of Corsica, by M. Charles Depéret.—On some localisations of morphine in the organism, by MM. A. Antheaume and A. Mouneyrat.—New experiments on nerve irritation by electric rays, by M. B. Danilewsky.—The diurnal oscillatory movement of the atmosphere, by M. Dechevrens.—On the tornado of June 18, at Asnières, and the storm phenomena observed on the same day, by M. Joseph Jaubert.—On the tornado of June 18, by M. Léon Teisserenc de Bort.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Yew Trees of Great Britain and Ireland: Dr. J. Lowe (Macmillan).—Elektrische Ströme: Prof. E. Cohn (Leipzig, Hirzel).—The New Africa: Dr. A. Schulz and A. Hammar (Heinemann).—The Life-Histories of the British Marine Food-Fishes: Prof. McIntosh and A. T. Masterman (C. J. Clay).—Lectures on the Action of Medicines: Dr. T. Lauder Brunton (Macmillan).—Botanische Wanderungen in Brasilien: Dr. W. Detmer (Leipzig, Veit).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 86, 87 (Leipzig, Engelmann).—Monthly Current Charts of the Atlantic Ocean (London).—Die Mechanik in Ihrer Enwickelung: Dr. E. Mach (Leipzig, Brockhaus).—L'Année Biologique, Première Année 1895 (Paris, Schleicher).—Macmillan's Geography Readers, Book 4 (Macmillan).—Thirty Years of Teaching: Prof. L. C. Miall (Macmillan).

PAMPHLETS.—Die Gesetze der Rotationselemente der Himmelskörper: C. A. Lilje (Stockholm).—The Extinction of War, Poverty and Infectious Diseases (Truelove).—The Science of Speech: A. M. Bell (Washington).

SERIALS.—Engineering Magazine, June (Tucker).—Botanische Jahrbücher, Dreiundzwanzigster Band, 4 Heft (Leipzig, Engelmann).—Journal of the Institution of Electrical Engineers, June (Spon).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, Part 1 (Philadelphia).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften, Math. Naturw. Classe, 1896, i. and ii. (Prag).—Twentieth Annual Report of the Connecticut Agricultural Exploration Station (New Haven).—Archives of Skiagraphy, No. 4 (Rebman).—Good Words, July (Isbister).—Sunday Magazine, July (Isbister).—Longman's Magazine, July (Longmans).—Humanitarian, July (Hutchinson).—Aus dem Archiv der Deutschen Seewarte, xix. Jahrgang, 1896 (Hamburg).—Séances de la Société Française de Physique, 1896, 4e Fasc. (Paris).—Transactions of the Leicester Literary and Philosophical Society, Vol. iv. Part 8 (Leicester).—Manchester Microscopical Society, Transactions and Annual Report, 1896 (Manchester).—Reliquary and Illustrated Archæologist, July (Bemrose).—Contemporary Review, July (Isbister).

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THURSDAY, JULY 8, 1897.

BICYCLES AND TRICYCLES.

Bicycles and Tricycles. An Elementary Treatise on their Design and Construction. With Examples and Tables. By Archibald Sharp, B.Sc., Whitworth Scholar, Associate Member of the Institution of Civil Engineers, Mitglied des vereines Deutscher ingenieure, Instructor in Engineering Design at the Central Technical College, South Kensington. With numerous Illustrations. Octavo. Pp. xviii + 536. 565 Figures. Index. (London, New York, and Bombay: Longmans, Green, and Co., 1896.)

IT is difficult to know who to congratulate most, the author of this really valuable work or the public, especially the cycle manufacturing branch of it, for whose edification and improvement it has been written.

The second paragraph of the author's preface so aptly summarises the need for such a book that, in spite of its length, it is worth quoting in full.

"The present type of rear-driving bicycle is the outcome of about ten years' practical experience. The old 'Ordinary,' with the large front driving-wheel, straight fork, and curved backbone, was a model of simplicity of construction, but with the introduction of a smaller driving-wheel, driven by gearing from the pedals, and the consequent greater complexity of the frame, there was more scope for variation of form of the machine. Accordingly, till a few years ago, a great variety of bicycles were on the market, many of them utterly wanting in scientific design. Out of these, the present day rear-driving bicycle, with diamond frame, extended wheel base, and long socket-steering head—the fittest—has survived. A better technical education on the part of bicycle manufacturers and their customers might have saved them a great amount of trouble and expense. Two or three years ago, when there seemed a chance of the dwarf front-driving bicycle coming into popular favour, the same variety in design of frame was to be seen; and even now with tandem bicycles there are many frames on the market which evince on the part of their designers utter ignorance of mechanical science. If the present work is the means of influencing makers, or purchasers, to such an extent as to make the manufacture and sale of such mechanical monstrosities in the future more difficult than it has been in the past, the author will regard his labours as having been entirely successful."

It is merely necessary for any one to go to one of the annual cycle shows and to overhear the, no doubt, honestly attempted explanation of the advantages of some hopeless device, and the apparent satisfaction with which some of these plausible follies are devoured by a section of the public, to feel that Mr. Sharp has expressed himself with too much enthusiasm. Perpetual motion is no more dead now than it ever was; in fact, in consequence of the extraordinary successes in the cycle business during the past year or so, vendors of schemes for creating power are doing a better business than ever. If fifty books as excellent as the one under review were in their hands, these people would always rise superior to the absurd limitations which mere conventional mechanicians recognise.

The real value of Mr. Sharp's book will, in the main, be felt by the manufacturers, who, in many cases, possessed of mechanical instinct, but without sound technical training, are honestly attempting to improve their produce. If any of them is able to handle elementary algebra and geometry, which is all that is asked of the reader, he will be taken in the first portion of the book through a course of instruction in which the principles, so far as they are required for cycle design, of kinematics, statics, dynamics, friction, and the stresses and strains in simple and compound structures are explained in a manner which is admirable. If he is not able to make use of the very elementary mathematical processes employed, he may yet follow much of the reasoning.

The first of the three parts into which the book is divided, is in reality itself an excellent text-book which has the unusual merit that it is not written for students or to meet a syllabus, but simply with the object of enabling any ordinary person with the usual school education to obtain a clear insight into the principles of construction and design. If there is one chapter in this part which will be valued more than others it is the one on bending, in which the theory is explained and then applied to the case of ordinary beams and tubes of various sections The numerical tables in which the sectional areas, weights per foot run, and moduli of bending resistances of solid bars and of steel tubes, should be of use to the designer.

The second part of the book, in which the well-known machines which have taken their part in the evolution of the modern cycle are described, while interesting in many ways, is of decidedly less utility than the first or last, or rather it would be so if it were not fortified by chapters on stability of cycles, steering of cycles, resistance of cycles, and gearing in general.

The third part, which is the largest, is simply one on details; but where there are such a host of details as there are in a bicycle, and each becomes the subject of an essay, the proportion assigned cannot be considered too large. For instance, seventy-two pages are devoted to the frame and to the stresses to which it is subjected Wheels, bearings, chain and other gearing, tyres, pedals, cranks, springs, saddles and brakes are all discussed at length.

Before examining this book more in detail, it may be worth while to say that Mr. Sharp is well known as an ingenious and sound mechanical engineer, so that readers of his book may be well assured that if they come across any statement which seems at variance with their ideas, or with what appears to be common sense, or even with the convictions of racing men, the statement is nevertheless one to be considered carefully.

The chief doubt which occurs to the writer of this review is whether the first 110 pages should have been written at all. This part is, after all, merely a text-book of mechanics, put together, it is true, in such a manner as to give prominence to the problems which a study of the cycle presents, but nevertheless a text-book abstract and black-boardy. If it is desirable that such a text-book should be incorporated in a work on bicycles and tricycles, then no fault is to be found with the substance of it, for it is clear, accurate, and to the point. At p. 110 the all-important question of the stiffness of tubes is reached. This is gone into at some length, both with circular and with other shaped tubes. Some attention has recently been given to the question of D-shaped tubes, which are being employed for the lower back fork of the rear-driven bicycle. The object of making these tubes of D-section

is to obtain the necessary stiffness with a narrow tube, as horizontal space is valuable at this part. Doubt has been expressed by cyclists upon the safety of D tubes when thus used. They will be glad to hear from Mr. Sharp, or to calculate for themselves if they like, as he has shown them how, that the D-tube is stiffer than a round tube of equal width and weight by rather less than 1 per cent. Mr. Sharp, however, advocates the use of tubes of rectangular section for this part of the machine, for they are roughly 33 per cent. stiffer than elliptical tubes of the same depth, breadth and weight.

In the chapter on the strength of materials, a result is given which will surprise those who do not realise the importance of depth in a beam, but who only consider tensile strength and density. Steel is so enormously strong for its weight that, with the exception possibly of some of the new alloys, it is the one material on which the designer of strong and light structures depends. Now in the case of solid beams of the same length, breadth and weight, a light material, such as wood, may be made so enormously deeper than one of steel, that the stiffness which depends upon the cube of the depth actually exceeds that of steel. For this reason a wooden cycle rim is lighter than a solid steel rim of the same width and strength. It probably is not lighter than a hollow steel rim of the same outer shape and weight, any more than a solid wooden beam would be lighter than a compound beam made of steel of the same width, weight and strength in which nearly all the material is at the upper and lower surfaces.

The concluding chapter of Part i. deals with the strength of materials. In this there are two sections of special interest to cyclists. The first relates to the "helical tubing" of the Premier Company. This is an ingenious composite tube made by rolling band steel in a helix, so that at no point has it less than two thicknesses, and then brazing all together. By this method of construction a higher grade of steel can be employed than any used in drawn tubes, and a gain of about 50 per cent obtained in tenacity. This, of course, is at the expense of ductility, so that while a frame built of helical tube will be stiffer for its weight than one of solid drawn tubing, it will, or perhaps it is better to say it should, give way suddenly to accidental stresses which would merely bend an ordinary tube.

The other interesting point is the effect of repeated small stresses of an amount which applied even many hundred times would be quite incapable of damaging a material. Certain parts of a bicycle are subject to alternate stresses in ordinary use, while others are constantly pulled in the same direction. The latter may therefore be made with a somewhat lower factor of safety than the former.

Part ii. is partly historical. This will be welcomed by readers very differently, according to their individual cycling experience. Those who have ridden since the 'seventies, or have followed the progress of the cycle, more especially in the last fifteen years, may turn over these pages with a certain melancholy interest, while those who have only recently joined the ranks of cyclists will probably be tempted by curiosity to learn something about the machines which so recently they despised. In the writer's opinion, the first fifty pages of this part is not likely to seriously interest any one for whom the really new and valuable part of the book has been written.

With Chapter xvii. the valuable portion of Part ii. begins. This is upon the stability of cycles. The author explains the bicycle balance by supposing the rider to steer unconsciously in such a curve that the centrifugal force balances the tendency to overturn. All that can be said of this is that when the rider is following a curved path he must lean over to the angle which every one knows, for this is what may be called the dynamical vertical; but small variations from this have to be counteracted just as much as small variations from the real vertical when a straight path is to be followed. Mr. Sharp speaks of the lateral oscillations that are necessary for stability as being pendular, so that a high bicycle has a slower period than a low. This, no doubt, is true in a way, but the essential difference between a hanging and an inverted pendulum are not pointed out. The former has a natural period—that is, it takes the same time to reach the vertical from any moderate inclination; but the inverse is not the case, an inverted pendulum has no natural time to fall from the vertical to any definite inclination, but only from one inclination to another, and the comparison of the periods between high and low machines can only be made when these inclinations are the same for both. The main point is that there is no natural period for the inverted pendulum, the time becoming greater as the start is made from a truer vertical, and also greater as the angle of fall becomes greater. For this reason it would seem that the more correct view is that the bicycle balance consists in merely running the wheel so as to bring the line of contact with the ground vertically under the centre of gravity, the vertical being the dynamical vertical for the particular speed and average radius of path.

There is one section in this very interesting part which is at variance with the supposed experience and almost universal belief of riders. This is upon the effect of pedal pressure upon side slip. Page 215 rather unnecessarily traces the forces upon the frame and wheel in consequence of pressure upon one pedal. Obviously no sustained pressure by the rider upon the pedal can produce a lateral force upon the tyres, however much riders may think the contrary; but is it not possible that this lateral force may exist, and to a more than perceptible extent, in consequence of the fact that it need not be sustained, that it is not one of the entirely balanced internal forces, but is unbalanced, the lateral momentum of the rider's body supplying the force which is external to the frame? This depends for its possibility upon its not being sustained, for if it were the rider would move laterally off the machine; as it is he begins to acquire a lateral velocity, which is pulled up and reversed at the next half-turn. This is the lateral equivalent of the objectionable vertical swaying of the body, which enables the rider to exert an effort on the pedal greater at the time that it is useful than that which the vertical force due to his mere weight would allow. In the middle of the stroke the vertical acceleration of the body is made a maximum, and so the position is at its lowest. At this time, therefore, a greater pressure is available; at the ends of the stroke, where pressure is less useful, less is applied, and gravity is

occupied in stopping the rise and starting a fall of the body. Thus the rider is able to store up the effect of gravity at the less useful, and employ it at the more useful periods, and so relieve his arms from the holding-down strain, which is so tiring.

After dealing with other points in connection with stability, the author comes on to steering in general, and to the difficult subject of steering and balancing upon the "Rover" type of safety without using the hands. Five pages of somewhat difficult reasoning are devoted to this point, and after the establishment of all the forces and couples which come into play, a theory is elaborated which should apply even to the case when the steering axis cuts the ground at the point of contact of the front wheel. It is often stated that riding without hands under these conditions is impossible; difficult it is certain to be, for this feat, as it used to be considered, is certainly easier when the castor action is moderately increased. It would be interesting if expert cyclists who have the means would see if they can succeed.

The writer noticed, when first practising to ride without hands, that the lateral hinging of the body about a joint in the neighbourhood of the saddle seemed to have a definite influence. This motion is evidently under the control of the rider, and so an actual variation of inclination can be forced upon the machine, the amount relatively to that in the upper part of the rider's body depending upon the moments of inertia of the two systems about their independent horizontal fore and aft axes. By this means it is certainly possible to make a rapid and temporary inclination of the frame, which, combined with the gyroscopic action of the front wheel, is all that is needed to control the steering. No doubt the forces calculated by Mr. Sharp act as he has explained, but to what extent they, or the temporary dynamical action just described, are those which are depended upon in practice, whether consciously or not, the writer is not prepared to say.

The chapter on resistance of cycles is very instructive. The conclusions are represented graphically, so that any one non-algebraically-minded can grasp the enormous importance of air resistance at high speeds. Extrapolating from these curves, it is seen that a man who can drive his machine under present conditions through the air at, say, 30 miles an hour, would, if road and machine resistance only had to be met, be able to drive at 330 miles an hour, or if he can actually go 20 miles an hour, he would be able to drive his machine 100 miles an hour. This shows the very essential part that pace-making plays in the cycle race. Whether Dr. Turner's theory on the fatigue caused by brain work in constantly determining the most suitable speed, plays any part or not, it is evident that a long machine with half a dozen riders upon it, or an autocar just in front of the racer, will make such a draught as materially to reduce the enormous resistance he would meet with if the air were still. The writer would like to propose a method to enable great speeds to be attained, which, however, is of spurious interest, since in real cycling the wind resistance must be overcome. All that is necessary is that a large box or small house with glass sides big enough to entirely surround the rider, but with a safe margin, should be dragged by steam or other power along at gradually increasing speeds until the rider shows that he is beginning to lag. Of course, there would be no floor or bottom to the box, and it should be made so that it would clear the ground by any predetermined amount. It might be safer if the house had no back.

Another suggestion offered more seriously where record-breaking without pace-making is the object, is that a day should be chosen when the barometer is very low, for a fall of an inch, if it reduced the air resistance by one-thirtieth, might mean a gain of a second in a minute, or a minute in an hour, *i.e.* if the corresponding diminution of oxygen in the rider's lungs did not compensate for the reduced resistance.

The chapter on gearing is one that cycle inventors would do well to study. It is interesting here to find the Simpson lever chain under the heading "Perpetual Motion." Mr. Sharp very clearly and forcibly points out the fallacy that renders auxiliary hand-power mechanism a practical failure.

Part iii. opens with two chapters upon the frame, which will probably be found to designers the most useful in the whole book. Graphic methods, explained in the first part, are employed to show how the stresses in a link-work frame can be calculated. It is clearly important that the design should be such in a cycle frame, that the members of the frame may be mostly in tension or compression, as they would be if they were pivoted and not brazed together. The difficulty of dealing with the actual case in practice in which they are brazed, and stresses other than tension and compression are certainly met with, is only referred to, but, perhaps wisely, the anxious engineer is not shown how to reduce these to figures.

It is a question whether too much stress has not been laid upon the necessity of straight members in a cycle frame, for in order to meet the racking and other stresses which must be met with in practice, a gauge of tube is necessarily employed, which, considering the frame as a mere girder carrying a dead weight, is quite absurdly strong, so that a moderate bending moment, due to the design, need not be feared when some distinct gain is effected in consequence.

This is more especially the case in the dropped frame which, unfortunately for themselves, ladies in this country think they prefer. Great abuse is often heaped upon the makers of machines with curved frames. Now, provided that the top and bottom members are kept apart, and the more so the better, and are effectively stayed at a few points, the bending stresses introduced by the curvature are quite moderate, and space is obtained where it is required, so that mounting and dismounting is more easy A further point is the extra steepness of the frame in front, which allows the skirt to hang more easily.

Mr. Sharp accepts the situation with regard to ladies' machines as he finds it at the present day in this country. Again, perhaps, he is wise. He assumes a drop frame to be a necessity. Now, if any person will depend upon reasoning alone, and pay no attention to the vagaries of fashion, he will see first, as is evident from Mr. Sharp's diagram, that the stresses in a so-called lady's "Safety" are greater than in one of proper design, so that in order to make it strong and stiff enough the machine has to be heavier than any that a man would ride, and is even then without that wonderful rigidity of the diamond frame.

Add to this the fact that the fair sex have not the strength or any of that recuperative power necessary in case of emergency that man possesses, and that they suffer many fold from the ever-disturbing wind resistance in consequence of the garments which fashion imposes upon them, and that because of these same garments they are in sorry plight in case of a moderate accident; with all this in the mind of a mere reasoning person, there is no wonder that he thinks of something else, the degree question at Cambridge for instance. Had the suburban ladies been given another year or so before the desire to ride a bicycle extended so far in the direction which is known from a mere social point of view as upward, it is possible that the change of attire would have spread gradually, and that now, or perhaps in a year or two, suitable costume would have been adopted as readily as the cycle jargon and slang so often met with. Ladies start with every natural disadvantage, and then they proceed to magnify them in a more effective way than their conscious ingenuity could devise.

The chapter on wheels is one which will be read with interest by riders especially. Here will be found a description of the author's tangent wheel, in which the spokes are not fastened to the hub at all! It is almost impossible to believe at first that spokes held in pairs to the hub by merely having their common centre portion wound a fraction of a turn round the hub will hold sufficiently tight to withstand all the twist that a strong rider can exert upon them. But the theory is convincing, and especially when steep-angled grooves are employed in which to lay the wire, no doubt can remain that this is the case.

Ball-bearings form the next subject, and these are treated far more thoroughly and scientifically than is usual. The actual want of absolute perfection in the ordinary bearing is pointed out, and a number of suggestions made for bearings in which the balls approach as near as possible to the state of pure rolling. The ordinary ball-bearing answers so well, in spite of the spinning and rubbing friction which accompanies the rolling, that it is hardly likely that the more elaborate bearings, in which these defects are reduced or abolished, will take their place. At the same time, a discussion of them is of educational value to designers.

Chains and chain-gearing are dealt with very thoroughly and completely. There is one omission, however, which must be noticed, and that is all reference to the results of Hans Renold, of Manchester, who found that a small difference of pitch is desirable in the driving and driven wheel. The writer of this notice picked up one of Renold's pamphlets at a cycle show some years ago, and was much struck with the arguments there used. It may be that this is all common knowledge, or that it is mistaken; but either way, one would like to have had Mr. Sharp's views upon the subject.

Mr. Sharp explains the correct method to setting out chain wheels for long-link and for block chains; he is not afraid of criticising one of the chief companies.

"In Humber pattern chain-wheels the teeth are often quite straight (Fig. 451). This tooth form is radically wrong."

On page 417, Mr. Sharp points out a defect in a usual pattern of chain which the practical man would hardly expect. Here the plates of the chain are cut away on the side next the chain-wheel, so that the line joining the rivets is not in the middle of the portion that is left. If the plates were cut away on the other side as well, so as to leave less metal, they would be stronger still. In the next page there is a suggestion which seems valuable, namely, to make the side plates of metal which has been stretched beyond its elastic limit, and which therefore has an increased rigidity. As these links can never be subjected to compression, the objection to this procedure, which is met with in other cases—as, for instance, in Southard's twisted cranks—does not apply.

The bicycle chain is a more marvellous piece of mechanism than is generally supposed. The pins have to bear a force which is far greater than is prudent in ordinary structures, while the bearing surface of the blocks on the rivets have in use occasionally to bear more than twice the amount given by Prof. Unwin as the maximum value for bearings on which the load is intermittent and the speed slow.

The discussion on the variation of relative speed in the driving and driven wheel is curious rather than important.

One result of the rules given by Mr. Sharp for shaping the teeth of sprocket wheels is that even in elliptical wheels the teeth will have the same form as in circular wheels of any size, so that the same cutters can be employed for all wheels if adapted to the tooth face, and not made simply to plough out the space between two teeth at one cut.

The practical reader would like to know whether the tooth forms recommended work well in practice, for there is undoubtedly much prejudice in favour of the patterns of our standard makers, whether condemned by Mr. Sharp or not.

Toothed-gear wheels are treated at length. The theory is, of course, common knowledge, but it is very well put, and the results of a paper on circular-wheel teeth, published by the author in the *Proceedings* of the Institution of Civil Engineers, are given also. Toothed-wheel gears follow. The mechanical reader who is not already acquainted with these, will be surprised at the ingenuity and perfection which are embodied in this class of work.

There is much remaining unnoticed, but the length to which this review has reached is such that many interesting points cannot be even mentioned.

"Bicycles and Tricycles," by Sharp, has taken its place as the one standard book which ought to be found wherever cyclists do congregate, and which no one designing or inventing any detail connected with a bicycle should fail to possess. C. V. BOYS.

THE GEOLOGY OF THE BRITISH ISLES.

Geological Map of the British Isles. Originally compiled by Sir Archibald Geikie, LL.D. Revised and extended by Alexander Johnstone, F.G.S. (Edinburgh and London: W. and A. K. Johnston, 1896.)

Mineralogical Geology: a Synopsis for the Use of Students. To accompany W. and A. K. Johnston's Geological Map of the British Isles. By Alexander Johnstone, F.G.S. (Same publishers as above, 1897.)

THE first of these works is by a long way the best and most convenient geological map of the British Isles, both for lecturers and students; and this new and greatly

revised edition has added considerably to its utility. It is, indeed, not likely to have a serious rival until the completion of the index-maps of the Geological Survey; and these will still be on too large a scale for the purposes of a comprehensive view. On the present map, fourteen miles go to an inch; and we are glad to see that a scale of kilometres is added. The colouring is clear and bold; and a number of small-type notes along the coast call attention to local details, as is customary in British maps of an educational character.

A series of well-chosen longitudinal sections occupies the blank spaces in the surrounding seas. It would be an advantage, in the next edition, to be informed as to the length of each section in miles, since some are naturally of a much more general character than others. In one, moreover, the term "Neocomian" is used, though it does not occur in the Table of Systems which forms the index. In another, owing, probably, to the small scale, there is a striking unconformity between the London Clay and the Bagshot Beds of the London basin. Teachers will be glad to have the Erriboll section, as an example of the northern thrust-planes; and the whole series will prove of constant service.

In the index, we note with pleasure the use of "Stonesfield Flag"—an "s" is probably omitted—for the well-known but misleading "Stonesfield Slate." In the Pre-cambrian group, the Caledonian Schists, the Hebridean, and the Dalradian, are separately coloured; and it is here that the map is in course of time likely to undergo modification. It has had the advantage of following Sir A. Geikie's recent edition of his map of Scotland, and is naturally a great improvement on other available wall-maps, in which all the schists east of the Torridonian border are classed and coloured as Ordovician. Ireland receives similar treatment; but here again some reminder is required of the prudent and cautious language with which the term "Dalradian" was introduced to geologists by its author. The Ordovician areas of eastern Ireland are also likely to become broken up, through the discovery, now announced, of several Silurian districts in their midst.

In South Wales we have a doubtful boundary, a dotted line, drawn between Silurian and Ordovician; and in many other of the older areas the map draws attention to recent observations. Even the Lenham Beds receive proper recognition along the scarp of the North Downs.

In trying to separate the Old Red Sandstone of southern Ireland into an upper and a lower division, Mr. Johnstone has naturally fallen into the common pitfall. As a matter of fact, the Dingle promontory and the region south of Omagh are the only safe areas where the Lower Old Red Sandstone can be marked out. Prof. Hull drew a provisional line across the centre of the county of Cork, which Mr. Johnstone properly puts aside, as being merely a suggestion. But he carries his Lower Old Red Sandstone along the south of the Blackwater, and colours the same rocks, where they emerge on the north side of the synclinal, as Upper Old Red Sandstone. The logical thing seems to be to use one tint at present for the main Irish Old Red Sandstone, and to split it into two minor tints for the benefit of the Dingle and Tyrone areas.

A few misprints require revision in the notes along the coast, such as "roches montonées," "Permiam," and "Greenstones" for the town Greystones. There are two references to Eocene plant-beds at Portree, but none at Ardtun, although the unimportant tachylyte at the latter point is mentioned. When we find, however, Radiolarian cherts and the Dover coal among the recent additions to our information on the map, we are not inclined to point out small omissions. We may rather end, as we began, by recommending schools, teachers, and public institutions to place this clear and conscientious work, without delay, by the side of any older general map which they may happen at present to depend on.

The earlier edition of Sir A. Geikie's map was accompanied by a concise handbook dealing with the geological structure of the British Isles. Some such book is obviously desirable, and the new map has provided an excellent opportunity. The progress of our views regarding the relations of certain strata could have been pointed out, and the meaning of such terms as "Dalradian," "Ordovician," &c., could have been made clear. There was ample room for a picturesque and yet accurate description of the features recorded in the map itself, prominence being given to those aspects of the country that would strike the ordinary traveller.

In what sense, however, Mr. Johnstone's tabular treatment of elementary mineralogy "accompanies" the map of the British Isles is indeed hard to discover. The author has given excellent and judicious prominence to the localities in which the several minerals occur in the British Isles; and a series of plates of British fossils occurs as an appendix, repeated, if we mistake not, from the borders of the original map. The revision of the names on these plates still remains to be done; we have "Fenestalla," "Rhynconella" more than once, "incrasata," "Cyrene," and divers similar slips. One Eocene mammal is even labelled "Palæo magnum." Our old friend, the seated Pterodactyl, still appears with his five digits on the hand. However, it may be justly urged that these illustrations have nothing to do with the book under review, which is an introduction to the study of minerals. As a book of reference for well-taught students, it may have its value; and we suspect that it has been compiled from notes already found useful by the author in his own courses of instruction. But it suffers from somewhat imperfect proof-reading, as in the case of the formulæ of the felspars on page 7; the mica formulæ also surely require revision. Where, moreover, are "Pary's Mine," "Magee Island," "Penmaen Maur," "Corinthia," and a few others?

We confess to feeling afraid of a small work so full of facts and figures; but its compilation must have involved serious work. The subject is plunged into abruptly, as when we are told in a foot-note on page 11 that "a growing together of two or more crystals constitutes a macle or twin." It is satisfactory to find a fuller treatment of twin-crystals on page 45; but the beginner is then informed that "when chemically and physically similar crystals at an early phase of their existence unite at inversely dissimilar parts to form a compound crystalline body, the product is called a twin macle, or hemitrope. . . . The plane of junction (*plane of composition*) is throughout the *twinning plane* in young

forms." This makes us truly wish for a teacher at our elbow. The difference between young and old twins is new to us; the Carlsbad twins, by the above statement, were clearly never young.

Altogether, this book must be compared with our smaller treatises on mineralogy, and must be judged accordingly. As a reference-book for British localities of minerals and rocks it will undoubtedly be useful.

G. A. J. C.

OUR BOOK SHELF.

A Ride through Western Asia. By Clive Bigham. With illustrations. Pp. 276. (London: Macmillan and Co., Ltd., 1897.)

MR. BIGHAM gives a simple, straightforward and modest account of a journey of the "record-breaking" order. In a year and a month he travelled, mainly on horseback, from Constantinople through Asia Minor, Persia and Central Asia, reaching as far as Kashgar, thence returning *viâ* Siberia and Russia. The small size of the book is welcome, and indeed remarkable, as it shows that the author cherishes no undue opinion of his somewhat remarkable journey. It is to be regretted, however, that his duties as a correspondent at the seat of war deprived the proof-sheets of his personal revision, and that many slips, chiefly in place-names, have thus eluded observation. Mr. Bigham was possessed of the best qualities of an explorer determined to go through a given programme; but he does not mention the special object for his expedition, nor does he tell much which had not previously been placed on record. The object presumably was merely pleasure, and the points of original importance refer to matters of undoubted interest, but so intimately involving political questions as to be unsuited for special reference here.

Numerous quotations are given from Mandeville, Marco Polo, the Vulgate and other authorities, and the author assumes as matters of common acceptance several theories, anthropological and otherwise, which are either exploded, or are now looked upon with great suspicion by competent authorities. Perhaps the most interesting part of the journey was the trip from Teheran through Kashan, Ispahan, Shiraz, and across the Bakhtiari country to Dizful, down the Karun River, up the Tigris, and back to Teheran by Kermanshah and Hamadan. It is a pity that fuller details of the Bakhtiari country were not given. The same may also be said of the journey from Kashgar to Semipalatinsk, across the Tian-shan, so early in the year as the month of May. There was too much travelling compressed into the thirteen months to allow of the careful collection of local information, which might be of scientific value; but the book is attractively written with plenty of action, maps well suited to bring out the routes, and good illustrations.

Elements of Theoretical Physics. By Dr. C. Christiansen, Professor of Physics in the University of Copenhagen. Translated by W. F. Magie, Ph.D., Professor of Physics in Princeton University. Pp. xii + 339. (London: Macmillan and Co., Ltd., 1897.)

WHILE the small edition of Thomson and Tait's "Natural Philosophy" professed to supply the essential details of this reasoning, devoid of mathematical notation, the present treatise appears to perform the converse operation, of providing the student of Physics with the mathematical argument and equations he is likely to encounter, devoid of any appeals to experiment or numerical illustration. The book is therefore a very handy manual of reference for formulas, and the mathematical treatment is very elegant and condensed, not running to unnecessary luxuriance. As it is stated at the outset that the C.G.S. system alone is employed, there is no need for any specification of the units employed; although we think it would tend to clearness to mention them occasionally; and this can be done, on the Hospitalier System, in a very condensed form, thereby training the student not to shirk this most important detail of his practical work; thus, for instance, the number $1{\cdot}695 \times 10^{12}$, representing the modulus of elasticity on p. 81, is given in dynes/cm^2.

The subjects treated in the chapters are—General Theory of Motion, Theory of Elasticity, Equilibrium of Fluids, Motion of Fluids, Internal Friction, Capillarity, Electrostatics, Magnetism, Electro-Magnetism, Induction, Electrical Oscillations, Light, Thermodynamics, and Conduction of Heat. These subjects are all polished off in 333 pages; and as most of them are discussed ordinarily in separate treatises, each of, say, 300 pages to itself, the treatment in this work is necessarily very condensed, and the author cannot permit himself any following out of details, or Calculus dodging.

This will make the book a difficult one for a beginner to use, except as a handbook of reference, to be used in conjunction with a series of Lectures; and it was probably in that way that the treatise assumed its present shape.

G.

In Garden, Orchard and Spinney. By Phil Robinson. Pp. iv + 287. (London: Isbister and Co., Ltd., 1897.)

The Woodland Life. By Edward Thomas. Pp. viii + 234. (Edinburgh and London: Blackwood and Sons, 1897.)

THE critic to whom these volumes were entrusted read a good part of them with a growing sense of perplexity not unmixed with enjoyment. When he attempted to write down what he had found in them, he could for a long time do nothing but gnaw his pen. At last it occurred to him that almost any reader of NATURE would have found himself in a like difficulty, and that the best plan would be to speak of the books from his and their point of view. We, the readers of NATURE, are accustomed to read for information, and we judge of books mainly by the quantity and quality of the matter which they contain. Now the two books before us may be shortly said to contain no information at all; to give information is no part of their plan. They are akin to the sonnet, the symphony, and the landscape painting, and make their appeal to sympathies of which the mere naturalist is quite devoid. Even the dull soul of the mere naturalist is, however, faintly stirred now and then, as he reads these pages, wondering all the time what he can find to say about them. Mr. Phil Robinson throws in many a pleasant phrase, many an apt quotation, and there is plenty of movement in his descriptions. Mr. Thomas' touch is not so light, but among his abundant epithets are not a few which show real familiarity with the natural objects, especially the birds, which catch his eye. Though these books make no pretence of being founded on inquiry, nor of adding to knowledge in any way, it is quite possible that a competent judge of literary form would give them a good place as prose poems.

L. C. M.

Social Transformations of the Victorian Age. By T. H. S. Escott. Pp. viii + 450. (London: Seeley and Co., Ltd., 1897.)

THIS book calls for but a brief reference in these columns. It consists of a series of sketches of social and legislative changes which have taken place during the Victorian era, and points to some of the causes of these transformations. Education receives a fair share of attention, but the transforming influences of science occupy only a single chapter of sixteen pages.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Colour Photography.

I HAVE had a good many inquiries addressed to me about the Dansac-Chassagne process of colour photography, described in NATURE, February 4, 1897, and as I was to a large extent responsible for having drawn public attention in this country to the process, I am naturally anxious that those who feel an interest in the subject should have, at all events, such information about it as I can supply without a breach of the confidence with which I have been favoured.

First let me say that the information I can publish does not include any details as to the materials employed, or the method of their manufacture. The process is to be worked as a secret one, and the statements made to me as to the method of preparing the liquids used were confidential. This of course greatly affects the scientific interest of the question, but commercial considerations in this, as in many like cases, overpower scientific interest.

It is only quite lately that I have been able to make any fuller examination of the process, and such rough tests as I have made are very incomplete. They are, however, complete enough for me to say that, while they do not justify the claims originally put forward as to the completely automatic nature of the process, I yet cannot account for the results produced without admitting that the selective action claimed does to some extent exist; that the colouring matters applied to the photographic print have a certain tendency to attach themselves to those portions of the print which would be of a similar colour had the image been reproduced in natural colours, and also that the colouring matters, when applied in succession, do so combine or react on each other as to reproduce, approximately, the tones or tints of the original.

There are some other inaccuracies in the first description given to me, which I should like to correct. It does not appear to me that a special negative, or a special print, is any advantage. It certainly is not necessary. The process can be applied to any ordinary print on albumenised paper, or to any positive on an ordinary gelatine plate. It does not appear to work successfully with some, at all events, of the more modern printing-out papers. Nor is it a fact that during the process of treatment the positive has to be exposed to bright light.

This it will be said is different from the process as it was first described. Precisely. It is because of that difference, and because I was responsible for the publication of the first description, that I now ask you to allow me to inform your readers as to the real value of the process so far as I can estimate it at present.

The above conclusions are based on my own attempts, and some rather more successful) by my friend Mr. Herbert Jackson. Judging from the work of the skilled operators, whom I have watched in M. Chassagne's studio, I can only say that in their hands the process is certainly not entirely automatic. The operator requires to know generally what the colours should be, and the results largely depend on his judgment and skill in applying the colour in the right places.

But the practical outcome is that anybody, after a little instruction, can produce, with very great rapidity, coloured pictures which, as evidenced by the specimens shown in public, are of considerable merit. The result is obtained by first applying the liquids over the whole picture, and then working up the different parts of the picture by applying them locally. About the truth of this there can be no manner of doubt. Hundreds of persons in Paris have seen it done, and have admired the results. The difficulty is to satisfy oneself as to how far the process is purely mechanical, and how far it is a matter of skill. A certain amount of skill is required, but, admitting this, it appears to me that taking it at its lowest value, the process does provide a means of colouring photographs—and with approximate correctness—that has not previously been available.

Whatever may be the practical or commercial value of the process, it will prove of very great theoretical interest, if as an outcome it should be conclusively proved that any monochrome photograph has even the smallest power of colour selection, depending on the tints of the original; as this once established, some of our current photographic notions would be revolutionised.

HENRY TRUEMAN WOOD.

Telegraphy without Wires, and Thunder-storms.

I HAVE recently made experiments on telegraphy without wires, and during the last few days, which have been very hot, I have experienced certain phenomena which somewhat interfere with the reception of signals. The receiver used by me is constructed thus: a piece of goose-quill one inch long is stopped at each end with cork, two ordinary pins pierce each cork, their points being about $\frac{1}{8}$-inch apart; the intermediate space is filled with finely-powdered nickel; (experiments on the relative sensitiveness of receivers made with quill and glass show that those made with quill are more sensitive than those made with glass.) The receiver is attached to an acoustic resonator carrying an electrically driven tuning-fork (500 double vibrations per second). The receiver is placed in contact with the foot of the fork, where it is attached to the resonator. The receiver forms part of a circuit including a dead-beat galvanometer, a single dry cell, and a resistance of 1500 ohms. One terminal of the receiver is earthed, and the other is attached to a thick copper wire, 30 feet long, fixed to a post. The vibrating fork effectually maintains the high resistance of the receiver, except when it is affected by a spark at a distance. The galvanometer is then instantly deflected, but at once returns to a nearly zero position. While I was watching the spot of light of the galvanometer, I noticed that it was deflected when the transmitter was not in action; after some time distant thunder was heard; in some cases the time between seeing a deflection and hearing thunder was 25 seconds, a time corresponding to about 5 miles; by degrees the storm, though at some distance, caused the spot of light to be deflected up to 25 times per minute.

From what I noticed it is evident that signalling would be somewhat seriously interfered with by a thunder-storm even at a considerable distance.

I have used the tuning-fork method of shaking the receiver since last February, and have never seen it fail in its action. Another method which gives good results is to mount the receiver on a small projection cemented to the disc of a telephone, in the circuit of which an electrically driven tuning-fork and a battery are included.

June 26. FREDERICK J. JERVIS-SMITH.

Distant Cannonade.

IN answer to your note upon the distances at which Saturday's salute was heard (NATURE, July 1, p. 204), I have to say that I heard what I suppose was the salute here in Chelsea. I took it at first for distant thunder, and went to look at the sky and barometers.

The newspaper reports showed, since that, that the thunder-storm was much later; and I did not hear sounds of it at all. The sound reminded me rather of a *feu de joie* than of a salute, which is accounted for by the fact that the squadrons saluted in succession.

There is nothing unusual in the hearing of artillery at such a distance, about sixty statute miles. The Bombay time guns and salutes are often heard at the northern Mahim, a known distance of over fifty statute miles. They are, or were in my day, very modest affairs—old-fashioned twenty-four or thirty-two-pounder guns, loaded with four or five pounds of coarse black powder, not all of which was burnt. I was working at warning guns in that country myself for some years, and had to attend to such matters, but have no notes here from which I can give exact figures.

The target practice of the forts and turret-ships at Bombay was very easily distinguishable from mere salutes and time guns; not merely as a louder sound, but by being *felt* in the chest when those could only be heard. Probably some of your naval readers can tell us something of the guns and charges used at Spithead on June 26. It may be presumed that they were of more power than the old-fashioned artillery that I have mentioned; but still it is probable that they were the smallest guns of the fleet, and the saluting charges much less than those for service. The sound produced by modern powders, too, is probably very different in quality from that of the old black powder with which the late Prof. Tyndall made his experiments.

The subject is of very considerable importance, and any information that our "up-to-date" gunners can give us will be welcomed by all connected with the sea.

102 Cheyne Walk, Chelsea. W. F. SINCLAIR.

Rotifers Commensal with Caddis-worms.

IT may be of interest to record the fact that, like *Gammarus pulex* and *Asellus aquaticus*, the larva of *Phryganea grandis* is a host for the commensal rotifer, *Callidina parasitica*. On one specimen, taken near Potter Heigham Bridge, I found between fifty and sixty of these commensals. As is the case with the commensals of *Gammarus* and *Asellus*, those of the caddis-worm gradually disappear when the hosts are kept in an aquarium. *Rotifer tardus* was also found among the materials of the larval case. HENRY SCHERREN.

The Lost Books of Euclid.

WILL you or any of your numerous readers kindly let me know, through the medium of your journal, if the lost books of Euclid (Books vii., viii., ix. and x.) have been found and published in English; if so, the name of the editor and that of the publishing house.

I may say, in reference to this inquiry, that an Indian Prince, who is at present in this country for the Jubilee celebration, possesses a complete copy of Euclid in Sanskrit—no book or books missing. A. K. GHOSE.

6 Forest Road, Kew, June 8.

[WE are indebted to Mr. H. M. Taylor for the following information:—

The first English translation of the Elements, published at London in 1570, had the title (16 Books):—

"The Elements of Geometrie of the most ancient Philosopher Euclide of Megara, Faithfully (now first) translated into the Englishe toung by H. Billingsley, City of London. Whereunto are annexed certain Scholias, Annotations and Inventions of the best Mathematicians both of time past and in this our age."

The English edition of the first printed Greek text, published at Basel, contained all the extant works attributed to Euclid. This was published in 1703, at Oxford, by Dr. David Gregory, and was entitled "Εὐκλείδου τὰ σωζομένα."

See Encl. Brit., ninth edition, for further information.—EDITOR.]

ARCHAIC MAYA INSCRIPTIONS.

THERE can be no surer sign of the smallness of the number of persons in this country who take an interest in the progress of our knowledge of American archæology, than the fact that not many years ago the editor of this journal asked me to review my own work on the subject, a request which, as far as courtesy would allow, I succeeded in avoiding by effecting a compromise which resulted in the publication of a few general notes on the ancient civilisation of Central America (NATURE, April 28, 1892). The far more grateful task has now been entrusted to me of calling the attention of the readers of this journal to an essay on the Archaic Maya Inscriptions, by Mr. J. T. Goodman, of California, which has been published as an appendix to the archæological section of the "Biologia Centrali Americana."

It is to the liberality and sympathetic kindness of Mr. F. du Cane Godman and Mr. Osbert Salvin that my work on Central American antiquities is being published in its present sumptuous form. Their names, indeed, figure on the title-page as editors; but the old-fashioned and much abused title of patrons would be more appropriate in expressing an ideal relationship in which they have confined their editorial duties to giving the kindliest and most valuable advice, whilst leaving me an absolutely free hand in the selection of material, and relieving me of all expense of printing and publication, and the reproduction of photographs, plans and drawings, which already extend over 175 double quarto plates.

It is again to this same liberality that my friend Mr. Goodman's interesting essay owes its publication; and were he here I know how heartily he would join me, and I think I may add so would every other student of American archæology, in a grateful acknowledgment of the deep debt of gratitude we owe to the editors of the "Biologia." To Mr. Goodman, as to myself, has been accorded an unrestricted freedom in the expression of his views; and after fully acknowledging the assistance he has received on this side of the water, there are passages in the preface to his essay which may be taken to express a natural disappointment that the value of his work was not recognised, and its publication ensured in the land which he loves so well.

Such attempts as have previously been made to interpret American hieroglyphic inscriptions have been mainly directed towards the interpretation of the three or four Maya manuscripts or codices which alone have escaped destruction. Although Mr. Goodman has not failed to devote the most careful attention to that branch of the subject, giving years of study to the codices as well as to the Yucatec and Cachiquel Calendar systems, it is to the interpretation of what he terms the "Archaic system," that is to say, the system of notation employed in the carved inscriptions found amongst the ruins of Palenque, Copan, Quirigua, Menché and Tikal—an almost untrodden field of research—that the present essay is devoted.

It will doubtless be disappointing to the general reader to learn that the greater part of the carved Maya inscriptions deal only with dates and the computation of intervals of time; but this is a fact which has gradually been forcing itself on the minds of students.

As Mr. Goodman says:—

"It may appear absurd, at first thought, that temples, monuments and altars should be covered with elaborately carved inscriptions that record nothing but dates and other forms of time reckoning. But a little reflection should convince one that such inscriptions, under certain conditions, would not be preposterous, but the wisest and most useful of records. A calendar is an indispensable requisite of civilisation. The very attempt to construct one is the first step towards evolution from savagery, and a completed calendar of any kind is proof that the transition has been accomplished."

The work of constructing a satisfactory calendar system from the chaotic fragments of information which have come down to us, has been a work necessitating the most extraordinary patience and insight. Not only must such a system stand the test of application to the inscriptions which are already known, but it must be prepared to stand the further tests to which it will be continually submitted as hitherto undiscovered inscriptions are brought to light.

Of the methods employed by Mr. Goodman in the preparation of his calendar a slight sketch is given us, and he tells us how it was to the writings of Diego di Landa (A.D. 1566), the Bishop of Yucatan and arch-destroyer of Maya records, that he had finally to return as his only trustworthy guide.

It is impossible in a short notice even to touch on the numerous points which had to be considered in the preparation of the calendar tables which accompany Mr. Goodman's essay. The main factor is the concurrent use of two systems based, one on a year of 360 days, and the other on a year of 365 days.

The Chronological Calendar deals with the former system, the divisions of time being

20 days	1 Chuen.
18 Chuens	1 Ahau (360 days).
20 Ahaus	1 Katun.
20 Katuns	1 Cycle.

13 Cycles = 1 Great Cycle.

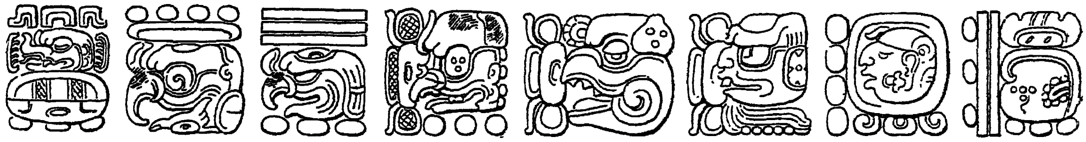
It is somewhat unfortunate that the Ahau, or period of 360 days, bears the same name as one of the twenty days of the Maya month, and in the same manner that the Chuen, or twenty-day period, is made to bear the name of another day of the month.

The Annual Calendar is divided into eighteen named

months, each of twenty named days, and one short month named Uayeb, of five days.

This Calendar repeats itself at the end of fifty-two years.

I called attention, some years ago, to the fact that the greater number of the carved inscriptions commenced with easily recognised series of glyphs with numerals or faces attached to them, which I called the Initial Series. Mr. Goodman now shows that the Initial Series expresses a date thus:—



1 2 3 4 5 6 7 8

(1) The Great Cycle sign. (2) The Cycle. (3) The Katun. (4) The Ahau. (5) The Chuen. (6) The Day. (7) The named day. (8) The named month.

As has been long known, each bar counts as five, and each dot as a unit. (The roundish marks *under* the glyphs are not part of the numerical series.)

The signs in front of the Ahau, Chuen and Day signs denote a "full count" of those periods. The date thus reads:—

54th	Great Cycle.
9th	Cycle.
15th	Katun.
"Full count"	Ahaus.
"Full count"	Chuens.
"Full count"	Days.
4 Ahau (day).	13 Yax (month).

A reference to Mr. Goodman's chronological Calendar shows that the 15th Katun of the 9th Cycle of the 54th Great Cycle commences with the day 4 Ahau, the 13th day of the month Yax, the date which is here given in the inscription. The combination 4 Ahau 13 Yax can only occur once in a period of fifty-two years.

One of Mr. Goodman's discoveries is the system on which the Mayas numbered the different series of time divisions. For instance, the twenty Ahaus are not numbered 1, 2, 3, &c., up to 20, but they were numbered 20, 1, 2, 3, &c., to 19.

If we should nowadays wish to use a similar notation, we should probably number the series 0, 1, 2, &c., 19; but it seems as though the Mayas, having no sign for 0, wrote the sign for 20 or a "full count" of Ahaus in the first place.

The 18 Chuens are in like manner numbered 18, 1, 2, 3, &c., to 17; the same sign being used for a "full count" of Chuens as is used for a "full count" of Ahaus.

As a "full count" of days (twenty) is a Chuen, a "full count" of Chuens (eighteen) is an Ahau, and a "full count" of Ahaus (twenty) is a Katun. The foregoing inscription may be read thus:—

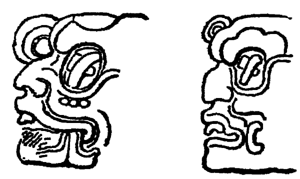
The 15th Katun of the 9th Cycle with no odd Ahaus, Chuens, or days added, begins with 4 Ahau 13 Yax.

Had the date been one including a specified number of Ahaus, Chuens, or Days, we should have had to make use of the Annual Calendar. Without giving examples and tables it is not easy to explain the method employed, which in practice is very simple, and almost invariably gives a satisfactory result; so that we can now locate in the Maya Calendar almost all the initial dates inscribed on the monuments, and many of those expressed in the body of the inscriptions.

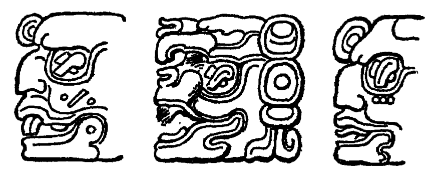
In the first chapters of the essay Mr. Goodman discusses each of the time periods used in the dates and computations, and identifies the glyphs by which they are expressed in the carved inscriptions.

Next follows a chapter on the "Burner Period" (260 days) and the "Bissextile Count," and then a series of chapters on the signs employed to express numbers, in addition to the well-known dot and bar system. The most interesting of these chapters is that devoted to the "Face Numerals," in which it is shown that the face so frequently met with in the inscriptions in connection with Cycle, Katun, and other signs for time periods, are in reality numerals, and the whole series of numeric faces from 1 to 20 is determined in some cases with certainty, and in others with a fair degree of probability.

The "face sign" for 10 is a death's-head, and it is interesting to note that some of the faces representing numbers from 10 to 20 are repetitions of the faces representing numbers from 1 to 10, with the addition of a death's-head jaw, or some other similar combination of 10 and the lesser numeral. Thus 6 is expressed by a grotesque face with a hafted stone axe in the eye.



And 16 is expressed thus—



the death's-head jaw replacing the more natural form of a jaw.

With the remaining chapters of this essay it is impossible to deal within the limits of this article; although the student may not always be able to agree with the conclusions arrived at, he will find an abundance of helpful suggestions. A table of signs is given which denote "the beginning"; numerous "directive" signs are distinguished, such as those indicating a reckoning "from the beginning of a cycle" "from the preceding date," &c., as well as "declarative" signs, such as "the beginning of a Katun," &c.

Then follow "Exercises in Decipherment" and "A Review of the Inscriptions"—that is, of those inscriptions of which drawings have already been published in the "Biologia Centrali Americana," and some others now in course of publication.

The essay is accompanied by a "working chart" in which the equivalent of each of the different time periods is given in days, and by a "Perpetual Chronological

Calendar"; also by a complete "Annual Calendar" for each of the fifty-two years of the Calendar round, and a complete "Chronological Calendar" for three great cycles. In these three great cycles all the dates as yet found in the inscriptions can be located; and, according to Mr. Goodman's theory of a Grand Era of seventy-three great cycles, these three great cycles are numbered the 53rd, 54th and 55th.

No doubt the first objection raised to the scheme will be the improbability of the Mayas having had a chronological system extending over 374,400 years, the number of years composing a Grand Era. And the objection will have all the more force, in that no such time period is mentioned by Landa or any other authority. Mr. Goodman says the Grand Era is a necessity to round off the various time periods on which the Mayas rested their computations. It does not appear to me that this would of itself necessitate a phenomenal antiquity for Maya civilisation, for the Mayas, like every other race, must have been confronted by the question, "When did time begin?" We ourselves have avoided the difficulty by taking a certain point of time, and reckoning forwards from it and backwards until we are lost in the mists of antiquity; but it must be remembered that it is only in the last few years that the date 4004 B.C. has disappeared as a marginal note from the first chapter of Genesis. Is it, therefore, impossible to believe that a people may have reckoned backwards to an imaginary beginning of time, fixed by a purely arithmetical calculation as the point when all the complicated time periods with which they were in the habit of reckoning could have started fair? How those time periods became so complicated, and needed such a vast stretch of time to work themselves out, is another matter—possibly it may have originated from the combination of various methods of reckoning time employed by different branches of the race. However, I must not start theorising on my own account, but refer the reader to the chapter on the "Era and Duration of the Archaic Maya Civilisation," where Mr. Goodman gives reasons for his belief in the great antiquity of Maya civilisation, and shows that between the earliest and latest dates recorded on the sculptures at Palenque there is a difference of 7082 years.

I am so fully aware of my own incompetence to deal with such an abstruse subject as the construction of Calendar systems, that I shall not venture on any critical review of Mr. Goodman's methods or conclusions; but I am glad to have an opportunity of saying that my acquaintance with Mr. Goodman and with his partner in his investigations, Dr. Gustav Eisen, commenced with a correspondence about the drawings of the inscriptions published in the "Biologia Centrali Americana"; and when I was afterwards able again to compare these drawings with the original sculptures, I found that the alterations of form suggested to me with regard to certain obscure and weather-worn minerals and glyphs had nearly always to be confirmed as correct. Then, as Mr. Goodman's methods became more familiar to me, I found myself constantly making use of the results at which he had arrived without any opportunity of acknowledging the source of my information. I was therefore urgent with him to publish the results of his researches, although he lingered fondly over his work, by no means considering it as yet complete.

Since commencing this article a photograph of a carved inscription, lately discovered on the banks of the Rio Usumacinta, has been forwarded to me from Yucatan by Mr. T. Maler. This inscription contains forty-eight glyphs. With the use of Mr. Goodman's tables I am able to locate (in the Maya Calendar) the date expressed in the inscription, and to follow five distinct reckonings to other dates—the reckoning made with the tables giving in every case the same result as that which is expressed in the inscription—and can thus ascertain with certainty the meaning of twenty-two out of the forty-eight glyphs contained in the inscription.

Alfred P. Maudslay.

TWENTY YEARS OF INDIAN METEOROLOGY.

Some years ago, when the Indian Meteorological Service was started, under the directorship of the late Mr. H. F. Blanford, F.R.S., he predicted that the Indian area would yield results second to none in importance in clearing up the mysteries which surround the working of atmospherical conditions. At that time the "Indian Meteorological Memoirs," designed to embody compilations and discussions of data in the spare time of the hard-worked officials of the service, were only just starting.

Six portly volumes of these Memoirs have now been completed since 1876; and, to judge from the character of their contents, and the evident growth of certainty and breadth of view with augmenting experience and improving data, Mr. Blanford's prediction is being fulfilled even more satisfactorily than he could have anticipated.

In 1883 a series of articles, by Mr. Archibald, appeared in Nature, in which vol. i., containing the first twelve Memoirs, were reviewed at some length. Since that date five more volumes have appeared, containing papers by the late Mr. H. F. Blanford, F.R.S., Mr. Hill, of Allahabad, Mr. Frederick Chambers, Mr. John Eliot, F.R.S. (the present head of the department), Mr. Dallas, and Mr. Archibald. In some of these papers the phenomena dealt with, such as hot winds and special storms, are of purely local incidence. In others, conditions outside the Indian area and their variations over a long course of years are discussed. We shall in the present article direct our attention principally to the light thrown upon the latter in the more recent Memoirs. Before doing this, however, allusion must be made to a very important series of papers, which form a large proportion of these volumes, in which the normal diurnal elements are discussed at twenty-five observatories scattered over the entire Indian area.

The adequate presentation of such normals is of vital importance to the efficient work of the Meteorological Department. To estimate an anomaly or abnormal, we must manifestly be able to refer to a correct normal. One of the points early foreseen by Mr. Blanford, and continually insisted upon by his successor, Mr. Eliot, has been the accurate determination of normals for as many stations as possible over the Indian area. At these twenty-five selected observatories, not merely have the normal means been determined, but the diurnal variations in temperature, pressure, wind, cloud, &c., have been worked out most exhaustively with the guiding aid of the harmonic formula, and the critical epochs determined with no stint of labour by the aid of the analytical process known as Jelinek's method of approximation. The series began with Sibsagar, by Mr. Blanford, on June 16, 1882, and was completed by a special monograph on Calcutta, by Mr. Douglas Archibald, in the present year. The area represented by these observatories extends in longitude from Aden to Dhubri in Assam, and in latitude from Leh in Thibet to Trichinopoly in Southern India. Many valuable points in connection with diurnal variations have been determined and discussed; and if ever the vexed problem of the cause of the daily variation in atmospheric pressure is completely solved, it will only be by the aid of this valuable series of papers.

In the Calcutta Memoir, which has only just reached us, the discussion embraces the temperature, pressure, and humidity observations, registered autographically

during the thirteen years 1881–1893, not merely with regard to the diurnal, but also the monthly and annual variations, together with a comparison of results at the other stations. This is probably one of the first complete discussions ever made of autographic records.

By adding on these thirteen years to the previous period of eye observations, a period is obtained sufficiently long to exhibit any secular periodicity, such as that in the mean sunspot period.

In the case of tropical air temperature, the existence of such a period is so well known that it has been frequently pointed out by Blanford, Eliot, and Hill in these Memoirs.

In the case of barometric pressure, as Mr. Blanford pointed out some years ago in his memorable discussion of the barometric see-saw between Siberia and Indo-Malaysia in the sunspot period, there is a small periodic variation of the barometric pressure of such a character that over India the pressure is above the normal in years about the minimum epoch of sunspots, and below it near those of maximum.

Calcutta, as Mr. Archibald states, is too near the axis of the see-saw (which is probably a little to the north of the Himalaya) to show a very marked variation; but the following figures for the mean cycle show that it has an existence, and must be reckoned with as a factor in the prevalent character of the weather in different years:—

Mean Annual Barometric Pressure anomaly at Calcutta (Alipore) in the eleven-year sunspot cycle from 1853 to 1893.

	Years of cycle.		Mean anomaly of annual barometric pressure unsmoothed. Inches.	
(1)	1853		−·0067	
(2)	1854		+·0007	
(3)		Two cycles intervene.	+·0132	Min. sunspot.
(4)			+·0077	
(5)			−·0012	
(6)			+·0042	
(7)			−·0032	
(8)	1893		−·0067	Max. sunspot.
(9)			−·0100	
(10)			−·0060	
(11)			−·0013	

These minute variations of pressure might appear too small to be associated with air movements and conditions of any considerable magnitude. It must, however, be remembered, especially by English meteorologists, that the barometric oscillation, corresponding to any given air-motion, is a direct function of the deflecting force of the earth's rotation, and therefore of the latitude. Consequently, a variation which would represent an insignificant disturbance in latitude 50° might be attended with serious consequences in India.

Thus the only marked feature of the great Madras drought and famine of 1876-77 was a slight excess of pressure over the whole area of drought, which nowhere exceeded ·04″ or ·05″ in amount.

The abnormal pressure conditions which enabled the Indian weather department to foretell accurately the last serious drought in India—that of 1891 in Rajputana—were small in amount, depending on variations and anomalies not exceeding ·05″, which is little more than one-third of the amount of the regular diurnal change between 10 a.m. and 4 p.m.

The range of pressure for the mean cycle for Calcutta in the present case is ·02″, and since the extreme range of annual means is only ·06″, it may be fairly presumed that the cyclical variation bears a sensible ratio to the variations which cause effective changes in the character of the years and seasons. When we further recollect the well-recognised fact that in Northern India the sunspot variations affect the summer and winter oppositely as regards rainfall, no doubts need be entertained that the state of the solar surface coincides with variations which are just as real, and probably no less practically important in their results, than those introduced by the diurnal and seasonal position of the sun in the sky.

It is indeed impossible to live in the tropics without being sensible of the reality of the sunspot influences. In years about the minimum spot epoch the mean annual temperature of the air is from one to two degrees higher, the range is increased, the wind force greater, and the rainfall less and more irregularly distributed than about the maximum epoch. Moreover, though the total sunspot effects are only a part of what occurs and are often masked by certain larger variations, whose origin is probably terrestrial and reactionary rather than solar and direct, the relation is recognised officially as a factor of practical importance, and allowed for in drawing up the forecasts of the summer and winter monsoons.

The whole subject of secular changes has received a decided impetus of late from the Memoir, Vol. vi. Part 2, on "Certain Oscillatory Changes of Pressure of Long and Short Period," by Mr. John Eliot, F.R.S. In this Memoir attention is drawn to a remarkable series of long-period waves of pressure over the Indian area, which vary from six months to two years in duration. The period investigated extends from 1875 to 1894.

These waves are believed to be of the nature of advances or checks in the general oscillatory system of air flow across the equator, which represents the so-called south-west and north-east monsoon winds of the Indian area.

As Mr. Eliot observes: "In part they are probably determined by seasonal conditions in Southern and Central Asia, and in part assist in determining the seasonal conditions in India, and perhaps also in Central Asia."

The extreme range of these fluctuations, measured by monthly abnormals over the whole period, amounts to about 0·118″, or about the same as the diurnal pressure range at sea-level in tropical India.

In discussing these waves, Mr. Eliot exhibits a similar series of oppositely phased oscillations in what are termed the vertical pressure anomalies between pairs of stations situated at considerable elevations in the Himalaya and on the adjacent plains.

These vertical anomalies (which are simply the variation at the hill stations *minus* the variation at the plain stations) are now so successfully employed in the preparation of the forecasts of the winter rains of Northern India, that they demand a little special reference.

In a country like India, where climatic changes far outweigh ephemeral weather changes, it is found that 95 per cent. of the irregular ephemeral changes of pressure are less in amount than the normal diurnal pressure range, the air movements are slow, massive, and regular in contrast with those of higher latitudes, and due quite as much to vertical as horizontal changes. It is therefore to be expected that the density or pressure of the lower mass of air between the hill stations at 7000 feet and sea-level, will often show variations of an entirely opposite character to that of the air above. In other words, abnormally high pressure below argues abnormally low pressure above, and *vice versâ*. As a matter of experience, this is found to be almost invariably the rule. When the pressure at the upper levels is lower than usual, the vertical anomalies would be *negative*, and when higher they would be *positive*. Mr. Eliot finds, moreover, that the vertical anomaly waves between stations such as Leh and Lahore, Murree and Peshawar, correspond all through to the long-period waves at the stations on the plains, but are exactly reversed in phase.

This shows either that the variation of flux is entirely confined to the lower atmosphere, or else that the vertical up and down flow remains temporarily uncom-

pensated at the higher levels. In any case, the conclusion is irresistible that the pressure variations are due to *flow* and not to a mere tidal rise and fall of the entire atmosphere.

A further proof that these so-called waves are connected with the seasonal transfers of air between Asia and the Indian Ocean, is the remarkable fact that the pressure variations at Mauritius are exactly contrary to those on the Indian plains, and *in general* similar to those of the vertical anomalies. In other words, the lower atmosphere over the Southern Indian Ocean and the higher Indian air strata are analogous termini of the harmonic oscillations in the general convective interflow over the monsoon and trade-wind area of Southern Asia and the Indian Ocean.

The chief critical epochs of both the vertical anomaly and general pressure anomaly curves observed over the plains, occur in March and November. These are, therefore, the months when the character of the ensuing season may be partially forecasted from an inspection of the pressure curves.

Experience has shown, as Mr. Eliot says, that "the primary maximum values of these oscillations [*i.e.* of the pressures on the plains] occur at the end of cold weather periods, characterised by abundant or excessive precipitation in Upper India and the Western Himalayas, and that the primary minimum values occur near or at the end of south-west monsoon periods during which the rainfall has been more abundant than usual."

If we remember that the cold weather rains occur in a stratum which mostly lies above the upper stations, and that the general variations above and below are almost invariably opposite in character, the empirical rule simply embodies the rational fact that the maximum rainfall occurs in connection with the minimum pressure of the containing air-stratum. Also since the vertical anomaly and plain pressure curves are inverse to each other, the rule may be put thus.

A descending vertical anomaly curve commencing about November, and a descending plain pressure anomaly curve commencing about March, indicate respectively the probability of heavy winter and summer rainfalls. Ascending curves commencing about the same epochs indicate the reverse seasonal conditions.

In the empirical form, these relations are now being successfully employed by the Indian Meteorological Department in its system of seasonal forecasts.

The marked tendency to a semi-annual or multiple semi-annual variation in the general pressure anomalies is curiously analogous to a similar period in cirrus bands noticed by Weber, in solar and lunar halos by Tromholdt, in the aurora Polaris, and in the spots and prominences on the sun.

What causes the equally marked differences which characterise the incidence of these barometric movements and their attendant conditions in different years, is still a mystery. Like most meteorological phenomena, they are probably a resultant of several components, solar, terrestrial, direct, and reactionary.

In any case, it is evident that the general outcome of these Indian meteorological researches, so far as relates to the question of long-period and universal weather changes, is decidedly encouraging, since it is plain that the majority of the anomalies in the Indian area are resoluble into harmonic periodic elements, leaving only a small residual to be labelled non-periodic and unpredictable. The moral, therefore, is not merely to extend terrestrial observation and the discussion of data over wide areas on broad, rational methods, but to endeavour to discover the precise way in which solar changes produce analogous long and short changes in terrestrial weather, especially where, as in India, these relations form such a dominant proportion of the total.

Since the above was written Mr. Eliot's interesting article on "Periodic Variations of Rainfall in India" has appeared.

Referring as it does particularly to the remarkable wave of rain and drought which has occurred during the past five years, it chiefly emphasises the remark made above, that the yearly anomalies in the general meteorological conditions are the resultant of several components—local, general, terrestrial, solar, direct, and reactionary. From the evidence adduced therein regarding the Indian Ocean area, and a general survey of conditions which have obtained in other parts of the world, it appears that this large oscillation has been of world-wide incidence. That it represents something in addition to the ordinary variations in the oscillatory flow of the trade-monsoon currents across the equator in the Indian Ocean. That it is therefore due to some abnormal extra-terrestrial—probably solar—influence, which must be referred to the solar physicists for its solution.

At the same time, its occurrence in no way invalidates the preceding conclusions deduced from a study of the ordinary yearly variations, or weakens the value of Mr. Eliot's vertical anomaly rule, as an empirical criterion of general monsoon characteristics.

MR. NEY ELIAS.

THE name of Mr. Ney Elias, whose death we briefly announced on June 17 (p. 159), is perhaps less familiar to the readers of travel and geography of to-day than it was to similar students of a quarter of a century since. In 1873 the Council of the Royal Geographical Society awarded him the Founders Medal for the successful accomplishment of a most remarkable journey through Western Mongolia. This was a district that no European had traversed since the days of Marco Polo, and notwithstanding the numerous difficulties which Mr. Elias overcame, and the personal danger in which he often stood, he was able to execute unaided a survey of the whole country travelled. The distance travelled was more than 2000 miles, starting from Kalgan, across the desert of Gobi, thence westerly to the Chinese frontier town Kwei-hua, and onward in a north-westerly direction to the Khangai range. The fanatical Mahommedan Mongol tribes, who were at war with the Chinese garrisons, prevented him journeying further to the south, to Kuldja, which was his proposed destination. The murderous devastation occasioned by this insurrection, and the impossibility of securing adequate assistance, compelled him to cross the Russian frontier and seek shelter at the town of Büsk. This journey, which he accomplished in about six months, was not his first experience in China. In 1871 he set out, with a single Chinese servant, to cross the entire continent of Asia, and a few years earlier had penetrated far into the interior with the view of discovering the causes that had forced the Lower Yellow River to forsake its bed and seek a new outlet to the sea. According to Chinese history, this river flowing through the great eastern plain of the country has had a very restless and eventful career. Nine times, within Chinese records, this river has varied its course, and sought a fresh estuary. The positions of the various mouths are scattered up and down the coast, covering, on the whole, five degrees of latitude. The date of the most recent of these fitful excursions is somewhat uncertain, but Mr. Elias concluded, from the observations which he made in 1867, that the change of bed was due to continuous flooding of the country in 1851-2-3, by which various barriers were broken down and changes of level produced. Mr. Elias was subsequently employed in India, and sent to Yunnan and Ladak; also undertaking a mission to Chinese Turkestan. Mr. Elias was a skilled observer in many branches of physics, and in the course of his travels enriched science by many observations. At

Bhamo, Sawuddy, and at Mandalay he carried on magnetic investigations and determined the variation. His longitudes are generally derived both by the method of lunar distances and by occultations. His skill as an observer is shown by the small differences that separate the results obtained by either method. At Mandalay, for example, the two values are separated by only a little more than a minute of arc. At Leh, actinometric observations engaged his attention; and if the series are not so long as those of Lieut. Hennessey and Mr. Cole, made at a station further south, they still possess great interest owing to the fact that the observations refer to a station so difficult of access. He rendered yeoman's service in the work of demarcating the frontier line between Burmah and the Shan States, and after a life of great adventure and of much service to science, he settled down as Consul-General at Meshed. For this most important post, and the management of the tangled web of diplomatic service, arising from its close connection with the Persian, the Russian, and the Afghan Governments, to say nothing of the restless Kirghiz tribes, he had admirably prepared himself. In 1885 he traversed the difficult Pamir country, and visited those districts on the banks of the Oxus, where may be met tribes of the most diverse races, and whose interests are as varied as the climates under which they dwell.

NOTES.

PROF. VIRCHOW, of Berlin, has been elected a Foreign Associate of the French Academy, in the place of the late M. Tchebicheff.

A CONFERENCE on the subject of the renewal of Antarctic exploration was held in the rooms of the Royal Geographical Society on Monday last, under the presidency of Sir Clements Markham. The main object of the conference was to induce the Australasian Premiers to bring the matter before their Governments, with a view to inducing them to contribute towards a British expedition under the auspices of the Royal Geographical Society. The conference was attended by, among others, the Duke of Argyll, the Marquis of Lothian, Sir Joseph Hooker, Admiral Sir George Nares, Admiral Sir Erasmus Ommanney, Admiral Sir W. J. L. Wharton, Sir John Kirk, Sir George Taubman Goldie, Prof. Rücker, and the Agents-General of Victoria, New Zealand and New South Wales. The Australasian Premiers were unable to be present. Speeches in favour of the object before the meeting were delivered by the chairman, the Duke of Argyll, Sir Joseph Hooker, Prof. Rücker, and the Agents-General. The chairman announced that the Council of the Royal Geographical Society were prepared to contribute any sum up to 5000*l.* to the amount which the colonial Governments might subscribe to the undertaking, and he expressed the hope that the matter might be pushed to a successful issue next year.

THE Institution of Naval Architects has, in honour of the Queen's Diamond Jubilee, organised an International Congress of Naval Architects and Marine Engineers, which was inaugurated by a conversazione on Monday evening. The congress itself was formally opened at the Imperial Institute on Tuesday by the Prince of Wales, who gave a short speech. On his departure, the chair was taken by the Earl of Hopetoun, the President of the Institution. After the President had delivered his address, papers were read by M. L. E. Bertin, on "Hardened Armour-plates and Broken Projectiles"; by Mr. C. E. Ellis, on "Non-inflammable Wood"; by Sir A. J. Durston and Mr. J. T. Milton, on "The History and Progress of Marine Engineering"; by M. P. Sigaudy, on "Water Tube Boilers." The session will conclude at Newcastle on July 15.

WE regret to announce the death, at the age of eighty-four, of Prof. J. J. Smith Steenstrup, of Copenhagen. After having acted as Lecturer on Mineralogy at Soröe, he was appointed, in 1845, Professor of Zoology and Director of the Zoological Museum at Copenhagen, retiring from his professorial activity in 1885. Prof. Steenstrup was the author of a number of scientific publications, several of which have been translated from the Danish into foreign languages.

AMONG other deaths we notice those of Dr. Alfred Stocquart, Chief Demonstrator of Anatomy in the University of Brussels, and Secretary of the Anatomo-Pathological Society, aged forty-one, of septic poisoning, contracted in making a post-mortem examination; and Dr. B. E. Cotting, for fifty-five years Curator of the Lowell Institute, Boston, Mass.

ACCORDING to a Reuter telegram of July 1 from Madrid, a dispatch from Manila gives some details of the eruption of the volcano Mayon. The village of Libong was completely destroyed, and 120 of the inhabitants were killed. The eruption was accompanied by a violent shock of earthquake.

THE Board of Regents of the University of the State of California have accepted the offer of Mr. C. F. Crocker, to defray all the expenses of an expedition to India to view the approaching eclipse of the sun. The expedition will remain in India from October next till June 1898.

INTENSE heat has prevailed for several days in Kansas and Arkansas, followed, on June 24, by destructive cyclones in Kansas and Missouri, and heavy storms in other States. During the storm at Hopkinsville, Kentucky, on the morning of the date mentioned, two earthquake shocks were felt. The vibrations were from west to east.

THE silver medal of the Zoological Society of London has been conferred by the Council on Mr. Alexander Whyte, who has lately retired from the post of Naturalist to the Administration of British Central Africa. Mr. Whyte accompanied Sir Harry Johnston when he first went out to Nyasaland in 1891, and has had the charge of the botanic garden at Zomba since that date, and performed other duties entrusted to him with zeal and fidelity. Under Sir Harry Johnston's instructions Mr. Whyte has made and sent to England from time to time large and most valuable collections in every branch of natural history. These have been transmitted to the British Museum through the Zoological Society of London, and have formed the subject of numerous communications by various experts to the scientific meetings of that Society. The fauna of Nyasaland, previously quite unknown, has thus become better understood than that of almost any other part of tropical Africa.

SIR MARTIN CONWAY and Mr. E. J. Garwood left London last week for Spitzbergen, their object being to continue the exploration of the interior of the main island begun by them last year. They are to be landed at King's Bay, whence they hope to make sledge expeditions over the northern ice sheet. They intend afterwards to revisit Horn Sound, and complete the scientific exploration of the southern peninsula.

DR. N. A. BUSCH, assistant-director of the Botanic Garden at Dorpat, has been commissioned by the Russian Geographical Society to undertake a botanical investigation of the Province of Kuban in the Caucasus, an almost unexplored territory. An assistant at the same Botanic Garden is also investigating the flora of the Government of Ssaratow.

A KEEPER in the service of the Zoological Society of London left London by the *Arundel Castle* on Saturday last, under arrangements sanctioned by the Colonial Office, to bring home

from Bechuanaland a young male giraffe, presented to the Queen on the occasion of her Diamond Jubilee by Chief Bethoen. The giraffe was captured three years ago, when quite young, in the Khalahari desert, and is now at Garanaka, ten miles north-east of Kanye, whither the keeper, on arrival at Cape Town, will proceed to receive it.

ANOTHER motor-cycle race is being organised in France. The date is fixed for August 22, and the course traversed will be from Paris to Cabourg, a distance of 215 kilometres.

A BIOLOGICAL station, containing aquaria, laboratories, rooms for collections and library, is in course of erection near Sebastopol, on the Black Sea. It is expected that the building will be opened for scientific work during the present year.

A LARGELY attended meeting, presided over by the Marquis of Tweeddale, was held on Friday afternoon last in the Botanical Theatre of University College, Gower Street, to inaugurate the personal memorial to the late Sir John Pender. The chairman handed over the sum of 5000*l.* to the College authorities to endow the electrical laboratory at University College, and announced that a portion of the amount subscribed had been expended on a bust of Sir John Pender, and that the balance would be given to the Glasgow University and the West of Scotland Technical College. Lord Kelvin, in a brief speech, said that it gave him great pleasure to have the opportunity of expressing his hearty concurrence with the resolutions of the Pender Memorial Committee as to the mode in which the fund collected should be distributed. He wished to speak of his own knowledge of what Sir John Pender had done. He remembered the first experiment that was made to lay a cable across the Atlantic. The scheme was supported by the then Mr. Pender, who in 1858 was one of the first directors of the company which was started to carry out the work. It was well within his recollection that all the directors resigned one after the other when the temporary success which attended the laying of the cable was followed so soon by failure. It was certainly a most discouraging result, but Mr. Pender was not to be disheartened. He was the only one to have the will and the power to keep the undertaking afloat, and from 1858 to 1864 he kept it afloat. The success which ultimately attended his efforts they all knew, and our colonies, he was glad to say, were now brought within speaking distance of the mother country.

A MONUMENT to the memory or Daguerre has been erected by public subscription at Bry-sur-Marne, and the inauguration ceremony was performed on Sunday, June 27. The memorial takes the form of a bronze bust placed on a stone pedestal, and is the work of Madame Bloch. At the close of the ceremony wreaths were placed upon Daguerre's grave.

THE outline programme of the Cardiff meeting of the Iron and Steel Institute, which is to take place from August 3 to 6, has now been issued. In it will be found full information as to each day's engagements. The following papers have been offered for reading: (1) "On Passive Iron," by J. S. de Benneville; (2) "On the Diffusion of Sulphides through Steel," by E. D. Campbell; (3) "On the Manufacture of Tin Plates," by George B. Hammond; (4) "On a Spectroscopic Analysis of Iron Ores," by Prof. W. N. Hartley, F.R.S., and Hugh Ramage; (5) "On Improvements in Shipping Appliances in the Bristol Channel," by Sir W. T. Lewis, Bart.; (6) "On the Iron Industry of Hungary," by D. A. Louis; (7) "On a Thermo-Chemical Study of the Refining of Iron," by Prof. Honoré Ponthière; (8) "On Carbon and Iron," by E. H. Saniter; (9) "On some Mechanical Appliances at Penarth Docks," by T. Hurry Riches; (10) "On the Application of Travelling Belts to the Shipment of Coal," by Thomas Wrightson.

THE *Times* Paris correspondent reports that at last Monday's sitting of the Academy of Sciences a paper by M. Tatin and Dr. Richet, on steam aerodromes, was read. The experiments of the authors are being carried on in emulation of those of Prof. Langley, the Secretary of the Smithsonian Institution, in Potomac Bay, near Washington. The French experiments have been made at Carquenez, near Toulon. The aerodrome weighed about 70 lb., or two and a half times as much as the American. The power of the engine was about the same—a little more than one-horse power. The French machine had two screws instead of one—one in front and the other behind. The maximum velocity obtained by MM. Tatin and Richet was greater, namely, 18 metres per second instead of 10, but the length of their run was 140 metres instead of more than a kilometre. The duration of the experiment was only a few seconds, instead of more than two minutes.

THAT science is being well fostered in our colonies can be gathered by a perusal of the *Transactions* of the Astronomical and Physical Society of Toronto, the seventh annual volume of which we have before us. This volume contains several interesting papers communicated by the active and corresponding members of the Society; and the numerous meetings seem always to have been well attended. The President's address delivered in January last, given in the volume, sums up the aim of the Society.

ATTENTION is called, in the *Engineer*, to a simple appliance intended as a substitute for the present crude method of fog-signalling on railways. The appliance is the invention of Mr. Pratt, of Bristol, and has recently undergone in a satisfactory manner a series of experimental tests on the West Lancashire Railway at Southport. The object of the invention is, in times of thick or foggy weather, when the ordinary danger signal would be invisible to the driver, to set automatically in operation the engine whistle, on passing the point where the ordinary fog detonator would be exploded. This is effected by a knife-cutter placed in the 6-foot way—and which is raised when the danger signal is put on—cutting through a brittle metal bar carried on the engine, the cutting through of which operates the lever acting upon the whistle, and which continues to sound until turned off by the driver, when the whole apparatus is automatically placed in position for operation when the engine again approaches a danger signal. The apparatus on the engine, which can be readily attached in any suitable position, consists simply of a pair of iron rods, between which slide, on half-rings, a series of the brittle metal bars referred to. When the bottom one is cut through it is thrown off, and brings down a lever rod attached to the engine whistle, which is at once set in operation; whilst the bar immediately above falls into its place, so that so long as the couple of rods between which these bars slide are kept supplied, the apparatus is always in readiness for signalling to the driver. The only real objection raised to the apparatus by the railway officials present was that it would be absolutely indispensable that every engine travelling over a line should be fitted with the appliance, and as over most main lines different railway companies have travelling powers, this would no doubt be a difficulty in the way of its adoption.

THE collection of Penguins in the Zoological Society's Gardens has received some valuable accessions in the shape of two examples of the little Blue Penguin of New Zealand (*Eudyptula minor*), and two specimens of the King Penguin from the Antarctic Seas, neither of which species are often seen alive in captivity. The former birds will be found in the Fish-house, where they are fed along with the other diving-birds, while the King Penguins have been located in an enclosure near

the Seal-pond, where they present a very attractive appearance with their sedate gesture and strangely contrasted colours. There are here also five examples of the Black-footed Penguin of the Cape to bear them company, but the King Penguins keep quite aloof from their smaller brethren.

IT is well known that the bison or buffalo (*Bison americanus*) is practically extinct in the United States as a wild animal, being now only to be found there in certain "parks" where it is carefully protected. But it is not generally so well known that there is still one district in the Dominion of Canada where the bison, or the variety of it called the "Wood-Bison," is still to be met with in its native wilds. The locality in question, which is perhaps one of the least accessible on the earth's surface, lies near Fort Chipewyan to the south of Great Slave Lake. It was visited in 1894 by Mr. Caspar Whitney, who has recently published an account of his unsuccessful hunt after this animal in his work entitled "On Snow-Shoes to the Barren Grounds." Before this interesting relict is quite exterminated, it is very desirable that a specimen of the Wood-Bison should be obtained for our Natural History Museum in South Kensington, where there is at present no specimen of this little-known mammal. It is probably only a local form of *Bison americanus*, but should certainly be represented in the National Collection.

A VERY compact and neat little camera has recently been put upon the market under the name of the "Photoscope," and is being made by Messrs. Ross and Co., of New Bond Street. This instrument is exactly like a binocular glass, and, in fact, it may be used as one when the fittings pertaining to the photographic attachment are removed. To use this for photographic purposes, one half of the binocular acts as a finder, and the other as the camera, the thicker ends of the binocular being placed up to the eyes, and pointed at the object to be photographed. The camera is arranged for carrying films, so that thirty or forty exposures may be made rapidly if required. The focussing is done after the manner of all binocular glasses, and the largest size picture capable of being taken by the instrument is 2 inches by 2 inches.

THE *Engineer*, commenting on a monograph by Mr. N. N. Banerjee, written under the auspices of the Bengal Government, says:—"The number of professional dyers in India is fast diminishing. Aniline dyes and cheap European goods are killing their trade. They are being compelled to turn their attention to new handicrafts, just as French competition and the vagaries of fashion caused the ribbon-makers of Coventry to seek a new livelihood in the manufacture of bicycles. Aniline dyes have made every man his own dyer. Formerly, the complicated processes by which indigenous dyes were prepared made the dyer a specialist. Now-a-days, anybody can dissolve the chemical powders sent out from Europe and colour his own clothes. The aniline dyes are more brilliant, and, to the native, they have the superlative merit of cheapness. They are not so fast, and they lack the delicacy of colour which, judging by the specimens annexed to the monograph, distinguish the Indian dyes. But their very gaudiness makes them more popular, and so the fate of the native dyer is sealed. Silk dyeing, cotton dyeing, and carpet dyeing are all declining. The fault, it should be added, is to some extent due to the conservatism of the native dyers themselves. They persistently adhere to their crude methods of preparing their dyes, and show a lamentable lack of ingenuity in preparing new designs."

THE *Weekly Weather Report* of June 26, shows that for the first half of this year the rainfall has exceeded the mean value in all districts, except in the north and west of Scotland. The greatest excess is in the south-west of England, where it amounts to 5 inches. This result is in some measure due to the occurrence of several heavy thunder-storms. During the week in question, some very high temperatures were recorded: Greenwich registered 90·2° in the shade, and 144·2° in the sun's rays, on the 24th, the day of the violent storm in Essex; while on the continent still greater heat was experienced, the shade temperature reaching 99° at Lisbon and Madrid, and 108° at Biskra (Algeria), in the early part of the week.

THE report of the Director of the Hongkong Observatory for the year 1896 states that the investigations of typhoons have been continued, and are now complete since the time of starting the Observatory in 1884. An important discussion of the anemometrical records obtained from the top of the Victoria Peak is being carried on, and will no doubt throw additional light upon the movements of the wind at elevated stations, which will be useful for storm-warning purposes. We notice that the weather forecasts during the year have been very successful, a result which is probably due to the receipt of three-hourly telegraphic reports, day and night, from Gap Rock Lighthouse, about thirty miles to the south of the colony. The examination of ships' logs has been continued with much activity; the observations for each month are tabulated in 10° squares, for the purpose of constructing trustworthy pilot charts of the Eastern seas. The number of observations so entered exceeds 131 thousand.

IN a note in NATURE for May 20, we called attention to Prof. Augusto Righi's investigations on electro-optics. Since then, we have received three further papers bearing on kindred theories from the same author. In one of these (*Atti dei Lincei*, vi. 10), Prof. Righi investigates the principal indices of refraction of selenite for electro-magnetic waves. In order to obtain a sufficiently large prism for his observations, the author had to make one of a number of small crystals cemented together with their axes parallel. In another paper, communicated to the Academy of Bologna (Bologna, Tipografia Gamberini, 1897), Prof. Righi deals with the orientation of a disc of selenite in a uniform electric field, and confirms Maxwell's theory according to which the three optical axes are coincident in direction with the three principal dielectric constants. A second communication to the Bologna Academy treats of secondary waves of dielectrics, and includes mathematical investigations for the effects of a dielectric sphere or cylinder.

WE have received a pamphlet entitled "An account of an investigation, by the late Joseph Baxendell, F.R.S., as to the short period cyclical changes in the magnetic condition of the earth, and in the distribution of temperature on its surface," by Joseph Baxendell, who read it recently before the Liverpool Astronomical Society. The author, from considerations arising out of an investigation of the irregularities which take place in the changes of some of the variable stars, was led to think that it was highly probable that the light of the sun, and also its magnetic and heating powers, might be subject to variations of a more complicated nature than had hitherto been supposed, and that changes indicated by the greater or less frequency of solar spots, others of a minor character and occurring in shorter periods, might also take place. A discussion of an immense amount of magnetical and thermometrical observations led the author to deduce the periods of variation, and conclude that (1) a ring of nebulous matter exists differing in density or constitution in different parts, or several masses of such matter forming a discontinuous ring, circulating round the sun in a plane nearly coincident with the plane of the ecliptic, and at a mean distance from the sun of about one-sixth of the radius of the earth's orbit. (2) The attractive force of the sun on the matter of this ring is alternately increased and diminished by the operation of the forces which produce the solar spots, being greatest at the times of minimum solar spot frequency, and least when the spots are most numerous. (3) The attractive force being variable, the

dimensions of the ring and its period of revolution round the sun will also vary, their maximum and minimum values occurring respectively at the times of maximum and minimum solar spot frequency. We may mention in this brief note that Leverrier was led to attribute a certain unexplained excess in the motion of Mercury's perihelion to the action of a disturbing body, a ring of small bodies, circulating round the sun within the orbit of this planet. It is stated in the paper that the eminent man of science, Dr. J. P. Joule, F.R.S., considered this hypothesis of Baxendell's very favourably, likening this supposed vibratory nebulous ring to a pendulum.

AN exhaustive memoir on the plague bacillus has appeared in the *Centralblatt für Bakteriologie*, and is from the pen of Dr. Rudolf Abel. In some respects this microbe resembles the cholera bacillus as regards its possible mode of distribution, and like it is apparently transmissible through water. Wilm states that he has discovered the plague bacillus in no less than three wells upon which suspicion had fallen. This investigator has also examined the vitality of the bacillus in various descriptions of water, and found it living for twenty days in distilled water. In well-water it survived sixteen days' immersion, and in sea-water six days. But these experiments were not quite satisfactory, inasmuch as considerable quantities of culture material were introduced into the waters along with the bacillus. Dr. Abel used distilled water and sterile, and also non-sterile, tap-water, and found that the plague bacilli in all cases were still living at the end of twenty days. In these investigations less culture material was added to the waters in question; but still it would have been undoubtedly better if the method had been adopted of first diluting the material of infection in water, so that the culture material was not *directly* introduced into the experimental waters. The plague bacillus is easily grown, and is very hardy, although in no instance have spore forms been discovered. Sunshine appears to be its most powerful natural enemy, for Dr. Abel found that one hour's insolation, when finely spread out in broth on cover-glasses, destroyed it. Kitasato in Hong Kong exposed bubonic pus on cover-glasses to sunshine, and found that the bacilli were killed in from three to four hours; similar results were obtained with pure cultures by Wilm. The bacillus is also sensitive to desiccation. Numerous investigations have been carried out by Dr. Abel on the action of disinfectants on the bacillus; and the memoir contains a mass of valuable information, gathered from various sources, on the character of this important micro-organism.

THE Secretary of Agriculture in the United States is arranging with recently-appointed ministers and consuls for an investigation of and report of agricultural conditions and work in the countries to which they are sent. Prof. Plumb, of Purdue University, Indiana, has been commissioned to report on the condition of dairying in certain countries he proposes to visit. Other specialists will go to Australasia and to Mexico, and the latter will collect specimens and data of what may be desirable from the semi-arid regions. Advantage will be taken of the visit of an expert to Central Asia, and tree seeds from there are expected. Prof. Hanson, of the Agricultural College of South Dakota, who is coming to Europe, will be sent on to Asia to bring back seeds of trees and legumes. Especial attention will be given to the search for vegetation of high and dry altitudes which may be introduced into America with success in similar altitudes.

THE June number of the *Mathematical Gazette*, published under the auspices of the Mathematical Association (formerly the Association for the Improvement of Geometrical Teaching), contains interesting papers on the projection of the sphere, by Prof. Alfred Lodge and by Mr. P. J. Heawood. Among the miscellaneous matter, teachers would do well to read Mr. R. F. Muirhead's brief note calling attention to certain flaws in the ordinary text-book treatment of uniform acceleration in dynamics.

AMONG the publications which have recently reached us attention may be directed to the *Photogram* for July, which contains several articles of interest. Dr. R. W. Shufeldt, in a short communication on the "Photography of Birds' Nests," pleads for good photographs of the nests of all birds that are nest-builders. His article is illustrated by a photograph of the nest of the cat-bird (*Galeoscoptes carolinensis*). Other articles in the same number are "Photography and Art," by C. E. Benham, and "The Restoration of Faded Prints," by A. Villain. In the latter two methods of restoration are described, and particulars given of a process by which greater permanence to photographic prints may be secured.—The *Irish Naturalist* has, as its leading contribution, "Some Observations by English Naturalists on the Fauna of Rathlin Island and Ballycastle District." The authors are R. Standen, Lionel E. Adams, G. W. Chester and J. Ray Hardy, who treat respectively of general observations, land and fresh-water mollusca of the Ballycastle District, the marine mollusca of Rathlin Island, and the Coleoptera of Rathlin Island.—The *Observatory* for July contains as frontispiece a striking photograph of the late Mr. E. J. Stone, F.R.S. In the July number of the *Strand Magazine* is the first of a series of articles by Grant Allen, entitled "Glimpses of Nature." The present instalment bears the attractive title of "The Cows that Ants Milk," and is well illustrated by F. Enock.—Another publication, the first part of which has just been issued, deserves mention. It is an album of pictures entitled "All about Animals," and contains well-executed reproductions of twenty of Gambier Bolton's well-known photographs.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*, var.) from Appantoo, Coomassie, presented by Dr. Thomas Pigg; an Orang-outang (*Simia satyrus*) from Borneo, presented by Dr. H. Dohrn; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. James Callingham; a Common Squirrel (*Sciurus vulgaris*), British, presented by Lady Acland Hood; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Mr. C. Ingram; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. M. A. Murray; a Common Seal (*Phoca vitulina*), British, presented by Mr. Wethenhogg; two Babirussas (*Babirussa alfurus*, ♂ ♀) from Celebes, presented by H.G. the Duke of Bedford; two White-crested Jay Thrushes (*Garrulax leucolophus*) from the Himalayas, presented by Mr. B. H. Jones; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss E. M. Kenyon Welch; a Blackbird (*Turdus merula*, var.), British, presented by Mr. A. Lawford Jones; eight Spotted Geckos (*Pachydactylus maculatus*), twenty-four Hispid Lizards (*Agama hispida*), thirteen Rough-scaled Lizards (*Zonurus cordylus*), two Delalande's Lizards (*Nucras delalandii*), two Three-streaked Skinks (*Mabina trivittatus*), two Aurora Snakes (*Lamprophis aurora*), two Infernal Snakes (*Boodon infernalis*), a Lineated Snake (*Boodon lineatus*), a Smooth-bellied Snake (*Homalosoma lutrix*), two Rough-keeled Snakes (*Dasypeltis scabra*), eleven Rufescent Snakes (*Leptodira kolambœia*), eight Crossed Snakes (*Psammophis crucifer*), five Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), a Yellow Cobra (*Naia flava*) from Port Elizabeth, Cape Colony, presented by Mr. J. E. Matcham; a Salvadori's Cassowary (*Casuarius salvadori*) from New Guinea, two Gentoo Penguins (*Pygosceles tæniatus*) from the Falkland Islands, an Indian Dial Bird (*Copsychus saularis*) from India, a Banded Ichneumon (*Crossarchus fasciatus*) from Africa, deposited; a Tayra (*Galictis barbara*) from South America; two Black Cuckoos (*Eudynamis orientalis*), three Ruddy Finches (*Carpodacus erythrinus*) from India, purchased.

OUR ASTRONOMICAL COLUMN.

WEINEK'S LUNAR ENLARGEMENTS.—Selenographers will be glad to hear that Prof. Weinek proposes to publish a Lunar Photographic Atlas, which will contain an accurate and artistic representation of the whole visible surface of the moon. The materials that will form the basis and bulk of this atlas have been mainly derived from the series of negatives of the Lick Observatory, which have been enlarged twenty-four times. The maps will be printed by the phototype process direct from Prof. Weinek's enlarged glass diapositives, and will be constantly under his supervision and control during their reproduction by the Art Photographical Institute of Carl Bellmann in Prague. The proposed scale of the atlas will be 4 metres to the diameter of the moon; there will be in all 200 maps 26 × 31 cm., and each sheet will give the selenographical latitude and longitude for the centre of the picture, and also the selenographical longitude of the terminator for the latitude 0°. This will greatly facilitate the arrangement of the sheets according to the relative positions of the lunar objects they portray. The publication of such an atlas as this, which requires a great deal of outlay, cannot be undertaken unless a considerable number of subscribers are forthcoming. Prof. Weinek appeals in the first instance to all the observatories of the world to become subscribers for the ten issues, each to contain twenty lunar landscapes. There should be no difficulty in obtaining a sufficient number of applicants, as such a useful and epoch-making publication in selenography should be in the possession of every observatory.

MARTIAN MARKINGS.—In the current number of *Knowledge*, M. Antoniadi brings together in an interesting summary all the more important observations made from the year 1864 of that well-known marking on the surface of Mars, namely, Syrtis Major. The discussion shows that, on the whole, decided changes have taken place in the form of this marking, and that its expansion has invaded the regions occupied by Mœris Lacus and Lilaga. Two new canals have also been recorded during the last few years in this region. The diagramatic sketch, showing the gradual changes recorded during the last thirty-three years, brings out very clearly the reason of the disappearance of the lake as such mentioned above. M. Antoniadi remarks, as regards the displacements of "seas" and "lakes," that "absurd and imaginary as they might seem to the ordinary reader, they are simply familiar occurrences to the areographer. Evidently the surface of Mars has some fixed areographical markings; but the stability of the lesser details and of the polygonians of the canal system is so frail, that at times the changes assume a fantastic, grotesque, and almost ridiculous character."

LEAKAGE FROM ELECTRIFIED METAL PLATES AND POINTS PLACED ABOVE AND BELOW UNINSULATED FLAMES.[1]

§ 1. IN § 10 of our paper "On Electrical Properties of Fumes proceeding from Flames and Burning Charcoal," communicated to this Society on April 5, results of observations on the leakage between two parallel metal plates with an initial difference of electric potential of 6·2 volts between them, when the fumes from flames and burnings were allowed to pass between them and round them, were given. The first part (§§ 1–4) of the present short paper gives results of observations on the leakage between two copper plates 1 centimetre apart, when one of them is kept at a constant high positive or negative potential; and the other, after being metallically connected with the electrometer-sheath, is disconnected, and left to receive electricity through fumes between the two.

The method of observation (see Fig. 1) was as follows. Two copper plates were fixed in a block of paraffin at the top of a round funnel 86 centimetres long and 15·6 centimetres internal diameter. A spirit-lamp or a Bunsen burner, the only two flames used in these experiments, was placed at the bottom of the funnel, 96 centimetres below the two copper plates. One terminal of a voltaic battery was connected to one plate, and the other terminal was connected to the sheath of a Kelvin quadrant electrometer. The other copper plate was connected to one of the pair of quadrants of the electrometer in such a way that by pulling a silk cord with a hinged platinum wire at its end, this copper plate and this pair of quadrants could be insulated from the sheath of the electrometer and the rest of the apparatus. On doing so with no flame at the bottom of the funnel, no deflection from metallic zero was observed, even when the other plate was kept at the potential of 94 volts by the voltaic battery; this being the highest we have

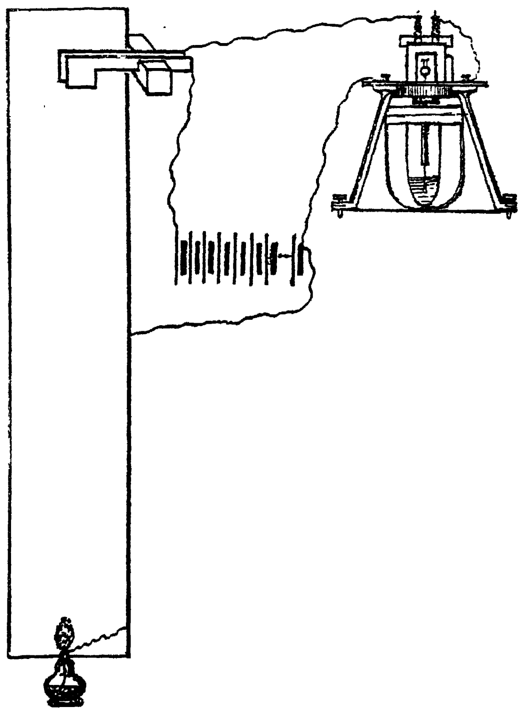


FIG. 1.

as yet tried. When the plate was kept at potentials of 2, 4 . . . 10 volts, the deflection from metallic zero in three minutes was observed; but for higher potentials, merely the times of attaining to 300 scale divisions from metallic zero were observed.

§ 2. The results obtained are summarised in the following table. In every case for potentials below 90 volts there was greater leakage when the uninsulated plate was connected to the negative terminal of the battery.

Spirit Flame.

Sensitiveness of electrometer = 60·7 scale divisions per volt. Hence 300 scale divisions corresponds approximately to 5 volts.

Difference of potential		+to plate, −to sheath		−to plate, +to sheath	
Volts		Deflection	Time	Deflection	Time
		Divisions	Min. Sec.	Divisions	Min. Sec.
2		+ 35	3 0	− 80	3 0
4		+ 92	3 0	− 133	3 0
8		+205	3 0	− 265	3 0
10		+240	3 0	− 311	1 15
Initial	Mean				
12	9·5	+300	0 53	− 300	0 38
18	15·5	+300	0 25	− 300	0 16
44·5	42·0	+300	0 4·5	− 300	0 4
89	86·5	+300	0 2·5	− 300	0 2·5

[1] Paper communicated to the Royal Society, Edinburgh, on July 5, by Lord Kelvin, G.C.V.O., F.R.S., and Magnus Maclean, D.Sc.

Bunsen Flame.

Sensitiveness of electrometer = 60·7 scale divisions per volt.

Difference of potential		+to plate, −to sheath		−to plate, +to sheath	
Volts		Deflection	Time	Deflection	Time
		Divisions	Min. Sec.	Divisions	Min. Sec.
2		+10	3 0	− 99	3 0
4		+73	3 0	−159	3 0
8		+200	3 0	−300	2 20
Initial	Mean				
12	9·5	+300	1 48	−300	0 48
16	13·5	+300	1 12	−300	0 30
19	16·5	+300	0 46	−300	0 18
31	28·5	+300	0 15	−300	0 13
47	44·5	+300	0 11	−300	0 8
75	72·5	+300	0 6·5	−300	0 5
94	91·5	+300	0 5	−300	0 4

§ 3. If the leakage in these experiments were proportional to the difference of potential, then the product of mean difference of potential into time should be constant for the same deflection from metallic zero. Taking the numbers obtained for the 300 scale divisions of deflection in virtue of the Bunsen flame, we have :—

Positive charge	Negative charge
s.	s.
9·5 × 108 = 1026	9·5 × 48 = 456
13·5 × 72 = 972	13·5 × 30 = 405
16·5 × 46 = 759	16·5 × 18 = 297
28·5 × 15 = 427	28·5 × 13 = 370
44·5 × 11 = 489	44·5 × 8 = 356
72·5 × 6·5 = 471	72·5 × 5 = 362
91·5 × 5 = 457	91·5 × 4 = 366

Thus it is proved that the leakage between two plates, each 10 square centimetres in area, 1 centimetre apart when the fumes from a Bunsen burner pass between them and round them, is approximately proportional to the difference of potential between them, when that difference is above 20 volts and up to 94 volts, the highest we have tried ; but that, below 20, it diminishes with diminishing voltages more than according to simple proportion.

§ 4. To determine the currents which we had in our arrangement, we took a movable plate of a small air condenser charged to a known potential, and applied it to the insulated terminal of the quadrant electrometer. In this way we found that a quantity equal to 0·15 electrostatic unit, gave a deflection of 300 scale divisions. Hence in the experiments with the Bunsen flame and with a potential of +94 volts kept on the uninsulated copper plate, the current to the insulated copper plate opposite to it, when 300 scale divisions was reached in 5 seconds, was—

$$\frac{0{\cdot}15}{3\times10^9}\times\frac{1}{5}=10^{-11}\text{ ampere.}$$

$$=\frac{1}{100000}\text{ mikro-ampere.}$$

§ 5. One of us about the year 1865, when occupied in experimenting with the latest form of portable electrometer, found that if it was held with the top of its insulated wire (which was about 33 centimetres long) a few inches below a gas-burner, a charge of electricity, whether positive or negative, given to this wire was very rapidly lost. The disinsulating power of flames and of hot fumes from flames was well known at that time, but it was surprising to find that cold air flowing up towards the flame did somehow acquire the property of carrying away electricity from a piece of electrified metal immersed in the cold air.[1] Circumstances prevented further observations on this very interesting result at that time, but the experiment was repeated with a portable electrometer in December of 1896, and we were made quite sure of the result by searching tests. During April and May of the present year observations were again made by means of (1) a multicellular electrometer reading up to 240 volts, and (2) a vertical electrostatic voltmeter (Fig. 3, p. 235) reading up to 12,000 volts. A steel wire 43 centimetres long was fixed to the insulated terminal of the multicellular electrometer, with its needle-point vertically below an ordinary gas-burner, as shown in Fig. 2.

§ 6. By means of a small carrier metal plate (a Coulomb's proof plane) a positive or negative charge was given to this wire and the quadrants of the multicellular till the reading on the scale was 240 volts. The leakage was then observed (*a*) with gas not lit, (*b*) with gas lit at different vertical distances above the point of the wire. We found that there was rapid leakage when the flame was one centimetre above the wire ; and the times of leakage from 240 volts to about 100 volts increased as the flame was raised to greater distances above the point ; or, otherwise, the

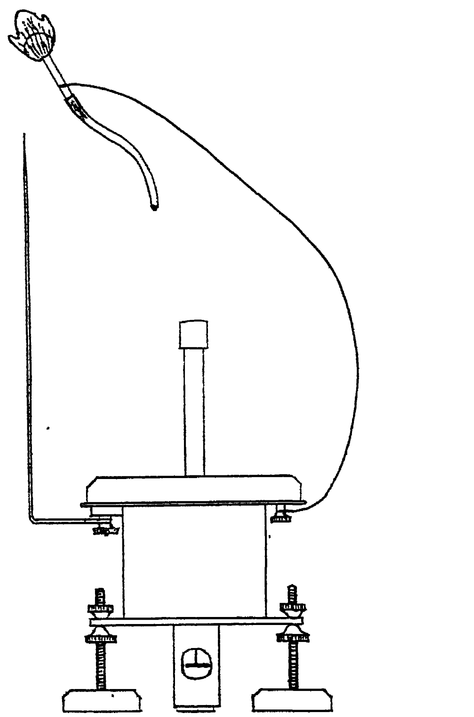


Fig. 2.

rate of fall of potential in one minute from 240 volts diminished as the distance of the flame above the point was increased. When the vertical distance of the flame above the point was 15 centimetres, or more, the time of leakage from 240 volts was practically the same as if the flame was not lit at all. A plate of metal, glass, paraffin, or mica, put between the point and the flame, diminished the rate of leakage. The leakage from 200 volts during the first minute is given in the following table, for different distances of the flame, with no intervening plate.

Distance of flame above point	Leakage during one minute	Remarks
Centimetre	Volts	
1·0	200 to 60 = 140	
1·5	200 to 92 = 108	
3·0	200 to 179 = 21	
6·0	200 to 196 = 4	
	200 to 197 = 3	No gas lit, but wire on the electrometer as in the other tests.*

* We sometimes found the multicellular electrometer to insulate so well that in five minutes there was no readable leakage from 240 volts.

[1] We have recently (June 1897) found the following statement, in Worthington's communication to the British Association (1889 Report, pp. 225, 227) "On the Discharge of Electrification by Flames" ; . . . "the observation seems to have been made by Priestley, that the discharge takes place *with apparently equal rapidity*, if the rod be held at the side of, or even below, the flame at the distance of, say, five centimetres" The four words which we have italicised are clearly erroneous, as we find *enormously greater leakage* five centimetres above a flame than five centimetres below it : but it is very interesting to learn that Priestley had found any leakage at all through air five centimetres below a flame.

§ 7. Similar experiments were made with higher voltages measured by the vertical electrostatic voltmeter, and we found that when the flame was three or four centimetres above the point, there was very rapid discharge; but when the flame was 60 centimetres or more above the point, the leakage from 3500 volts was practically the same as if the flame was not lit.

In place of the metal point, a round disc of zinc, 8 centimetres in diameter, was fixed, as shown in Fig. 3, to the end of another steel wire of the same length; and leakage from it to the flame above it, observed. For the same distance between the flame and either the point or the metal disc, the rate of leakage through the same difference of potential, was *less for the point than for the disc*. Thus with the flame 25 centimetres above the point the time of drop from 3000 volts to 2000 volts was 1 min. 53 secs., and with the flame the same distance above the horizontal plane of the disc the time of drop from 3000 volts to 2000 volts was 1 min. 14 secs. *This is a very important result.*

§ 8. Experiments were next made to find if, and if so, how much, the leakage is diminished by putting non-conducting plates of glass, paraffin, mica, between the point or disc and the flame. At a corner of each plate was pasted a little square of tinfoil, so

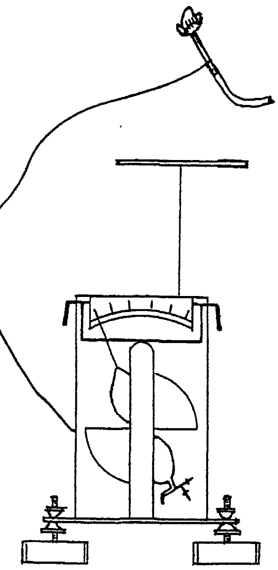


FIG. 3.

as to prevent any electrification of the non-conducting substance by handling. These pieces of tinfoil were always kept metallically connected with the sheath of the electrometer. Each plate was fixed with its under surface 1 cm. above the steel point. In preliminary experiments (of which a continuation is deferred until the insulation of the electrometer is made practically perfect by coating its vulcanite insulators with paraffin) the following numbers were obtained:—

I. *Glass Plate* 18 *cms. by* 19 *cms. by* 0·3 *cm.*

Distance of flame above point	Time of fall from 3000 to 2000 volts		Remarks
Cms.	Min.	Sec.	
—	5	30	Insulation test, with no flame.
12	2	5	Flame lit: no intervening plate.
,,	4	7	,, ,, glass plate between.

II. *Mica Sheet* 18 *cms. by* 9 *cms. by* 0·1 *cm.*

—	6	46	Insulation test, with no flame.
12	1	56	Flame lit: no intervening plate.
,,	3	50	,, ,, mica sheet between.

III. *Paraffin Plate* 11 *cms. by* 11 *cms. and* 0·75 *cm. thick.*

—	6	40	No flame. Insulation test.
12	1	53	Flame lit: no intervening plate.
,,	2	20	,, ,, paraffin plate between.

We hope to return to the investigation with the insulation of the electrometer perfected; and to determine by special experiment, how much of the fall of potential in the electrometer in each case is due to the electricity of opposite kind induced on the uppermost surface of the non-conducting plate, and how much, if any, is due to leakage through the air to the metal disc or point below.

§ 9. To test the quality of the electrification of both sides of the non-conducting plates of glass and paraffin, a thin copper sheet was fixed to one of the terminals of a quadrant electrometer, as represented in Fig. 4, where A is the plan of plate C attached to the electrometer, and B is the plate of paraffin or glass under test.

In the primary experiment (Fig. 3) the non-conducting plate was fixed in a horizontal position one centimetre above the electrified metal (point or disc), and eleven centimetres below the flame. A charge was given to the metal, to raise its potential to about 3500 volts. After some minutes, generally till the potential of the metal fell to 2000 volts, the non-con-

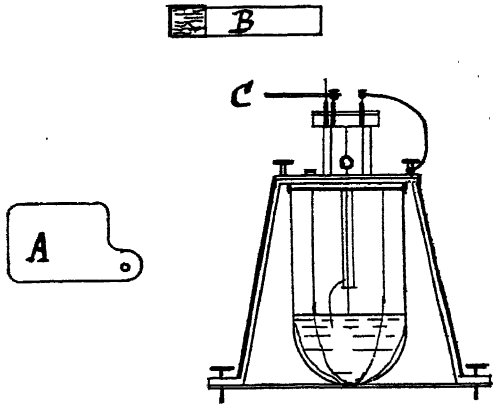


FIG. 4.

ducting plate was removed and placed, as shown in Fig. 4, above the metal plate C attached to the quadrant electrometer, and the deflection was observed. For a thin piece of glass (0·3 cm. thick) the whole effect of the two sides was negative when the electrified metal point or disc had been charged positively and *vice versâ*. But on putting two plates of glass above the electrified metal, we found the top plate to be oppositely charged and the under plate to be charged similarly to the point or disc, but not so highly. We found corresponding results with a plate of paraffin 0·75 cm. thick, and with two plates of paraffin 0·5 cm. and 0·75 cm. thick. When a plate of paraffin 3·25 cms. thick was used, we always found the top face charged oppositely to the charge of the metal, whether disc or needle-point, and the under face charged similarly to the metal below. Thus the apparent total charge of the two faces of a thin non-conducting plate is due to the fact that the face of the plate away from the electrified metal is more highly charged oppositely than the face next the metal is charged similarly.

A NEW LAW OF HEREDITY.

THE truth of a law of heredity proposed by Mr. Francis Galton, has been verified in particular instances, in a memoir[1] read by him before the Royal Society on June 3.

He first put forward the law, with hesitation, in his book "Natural Inheritance" (Macmillan and Co., 1889), page 134, because it was founded at that time almost wholly upon *à priori* grounds. Now, being found to hold good in a large group of

[1] "The average Contribution of each several Ancestor to the total Heritage of the Offspring," by Francis Galton, D.C.L., Sc.D., F.R.S.

cases, there is strong reason for its acceptance, as applicable generally to all qualities in all the higher (bisexual) animals. When it is applied to individual cases, minor corrections should of course be made in respect to sexual limitations, prepotencies of particular ancestors, and the like.

The law shows the proportion of the heritage that is contributed on the average by each parent, grandparent, great-grandparent, and so on. There *must* be an *average* contribution, drawn from each ancestral place *independently* of all the rest, because cases are familiar to observers in which a peculiarity found in some single ancestor has appeared in one or more of the offspring; the present law expresses its amount.

The general considerations upon which the law was originally founded, are four in number but not equally cogent; there is only one solution that satisfies them all. (1) The consequence of limitation in space on *particulate* germinal matter, which necessitates the loss of one-half of the total germinal material contributed by the two parents. This is confirmed by the commonly (though not universally) accepted fact of observation in the life-history of the germ. (2) The remark already made, that any ancestor however remote *may* contribute his peculiarity independently of the rest. (3) The contribution of the two parents to the child, being analogous to that of the 4 grandparents to the 2 parents, of the 8 great-grandparents to the 4 grandparents, and so on, make it probable that the latent links of the chain of ancestral contributions form a geometric series of terms, diminishing as we proceed from the ancestor downwards. (4) The sum of the contributed heritages must be equal to 1.

These four conditions are satisfied by the series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} +$&c. In other words by the supposition that the two parents contribute between them $\frac{1}{2}$ of the total heritage of the child; the four grandparents, $\frac{1}{4}$; the eight great-grandparents, $\frac{1}{8}$, &c. Or again, that a single parent contributes $\frac{1}{4}$; a single grandparent, $\frac{1}{16}$; and a single ancestor in the nth generation, $1/2^{2n}$. A noteworthy consequence of this is that all the 16 great-great-grandparents taken together, are no more efficient than a single grandparent, and only one quarter as efficient as a single parent.

This supposition does not run counter to the commonly accepted view that the true line of descent stretches from germ to germ, and not (except in, perhaps, a small degree) from person to person; the person must on the average be a fair average representative of the germ, consequently statistical averages which are true of the one, would be true of the other, also.

The verification of the above theory is the object of Mr. Galton's memoir. Appropriate materials for the purpose were at last found in the registered colours of the pedigree stock of Basset hounds. This stock was started some twenty years ago by Sir Everett Millais, who purchased on the continent 93 selected hounds for the purpose, and has subsequently interbred their most valuable descendants. A Basset Club has long been established, which publishes an occasional stud-book (the latest was in 1896) containing the registered name, parentage, date of birth, and breeder of each hound. The colours are not printed in it, but they are always entered on the form sent by the breeders to the Club, and Sir E. Millais kindly had them copied for his use. Now there are two, and only two, recognised varieties of these colours: the one technically known as *lemon and white* (the word "lemon" standing for any shade between yellow and reddish-brown), and the other known as *tricolour*, from its containing black as well. So there are only two alternative conditions to be considered: "with black" and "without black"; or "Tricolour," and "Non-tricolour"—say for brevity, T. or N. It is asserted that intermediate and doubtful cases between T. and N. hardly exist.

The result is a collection (1) of 817 hounds of registered colours, T. or N., descended from parents whose colours are also known. (2) Of these, in 567 cases, the colours of all four grandparents are known; again (3) of these, in 188 cases, the colours of all eight great-grandparents are known. These three sets form the material that is tabulated and discussed, and supplies the requisite means for comparing calculated results with observed ones.

There are numerous points dealt with in the memoir, and explained away, to which there is not space to speak of here; one only need be mentioned, namely the question whether either the sire or the dam is so prepotent in transmitting colour, as to make it necessary to treat the sexes apart. It proves that the dam is prepotent over the sire in this respect, but only in the proportion of 6 to 5; also that the neglect of sex made no sensible difference in a test case. Consequently all ancestral places in the same generation are treated as of equal average efficiency. In short, if n be the order of any given generation (counting $n = 1$ for parents, $= 2$ for grandparents, &c.), there are 2^n ancestral places in the nth order, and these contribute between them $1/2^n$ of the total heritage; consequently each ancestral place contributes $1/2^{2n}$ of it. If the same hound fills more than one ancestral place, he has to be rated separately for each of them.

The contributions from the unknown ancestry are reckoned as follows. It was found that 79 per cent. of the parents of T. hounds are T. also, and that 56 per cent of the parents of N. hounds are T.; consequently the unknown grandparents, great-grandparents, &c., of the T. hounds would have probably $(\cdot79)^2$, $(\cdot79)^3$, &c., of T., and those of the N. hounds would have $(\cdot56)^2$, $(\cdot56)^3$, &c., of T. A simple calculation shows that the sum of the T. contributions to the offspring of the unknown ancestry of each T. grandparent would be 0·0408, and that of each N. grandparent would be 0·0243; these values are used in discussing the set (2). In set (3) the great-grandparents are known, ignorance beginning above that stage; in this case, the pre-ancestral contribution of T. through each T. great-grandparent, is found to be 0·0102, and that through each N. great-grandparent is 0·0061. There is no need here to allude to minor corrections, noticed in the memoir, whose effect is too small to be worth regarding.

It thus becomes a very simple matter to determine the contribution from each several known ancestor as well as that from the unknown ancestry of each of them, and, by adding these together, to obtain a coefficient appropriate to any given group of similar cases, such as when multiplied into the total number of offspring, shall give the "calculated" number that are T.

The test of the truth of the theory lies in the accordance between these calculated numbers and the observed number.

Owing to the large proportion of T. hounds and to selective breeding in favour of T., the different possible matings are by no means equally common, those in which the known ancestry are all (or nearly all) N. being non-existent. The results for such as occurred, are summarised below (excluding seven cases, falling into three groups, that lay outside the limits of the Table for set 3). The coefficients are added to show the degree of variety in the test conditions. Fuller information is to be found in the Tables published in the memoir, out of which these figures are extracted.

CALCULATED AND OBSERVED VALUES COMPARED.

Set 2.

Coefficient...	·91	·83	·76	·68	·66	·58	·51	·43	·26	·18	—	Total
T. calculated	108	99	21	8	24	92	30	3	5	1	—	391
T. observed	106	101	24	8	20	79	36	4	7	2	—	387

Set 3.

Coefficient...	·96	·94	·92	·90	·87	·85	·83	·81	·81	·79	·77	
T. calculated	2	24	13	14	16	18	13	5	2	3	2	(continued)
T. observed	2	25	14	15	17	19	14	6	2	2	3	

Set 3 (continued).

Coefficient...	·75	·69	·67	·65	·64	·62	·60	·58	·56	·54	·52	Total
T. calculated	2	1	1	6	1	17	8	18	5	2	7	180
T. observed	2	1	0	5	1	16	12	8	9	1	7	181

Comparing the totals of each of the two sets, we see that the calculated results are practically identical with the observed ones, 391 with 387; 180 with 181; grand total, 571 with 568. There is therefore no *constant* error, the errors in individual

cases balancing one another. When we examine the several groups, 32 in number, which contribute towards the above totals, a remarkable amount of agreement is shown throughout between calculation and observation, such as would raise the art of breeding to a science of considerable precision. The most notable exception is in the sixth column of set 2, where the numbers are 92 and 79, but, as is shown in the memoir, the observed values run there so irregularly with their neighbours, that they cannot be accepted as true representatives. The causes of heterogeneity undoubtedly include the disturbing effects of close interbreeding, because particular hounds of good shape that have also considerable prepotency, are largely bred from.

The author mentions that he had made experiments with the coefficients, altering them slightly and recalculating, and that he found in every case a notable diminution in the accordance between calculation and observation; the test that the law has successfully undergone thus appears to be even more severe and searching than might have been anticipated.

It is hardly necessary to insist on the value to breeders of a trustworthy law of heredity. Vast sums are spent annually in rearing pedigree stock of the most varied kinds, such as horses, cattle, sheep, pigs, dogs, and other animals, besides flowers and fruits. Certainly no popular view at all resembles that which is put forward and justified in Mr. Galton's memoir, which is epitomised here so far as space admits.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Maine State College at Orono will in future be known as the University of Maine.

MR. MUIR, of Halifax University, has been appointed to the chair of Psychology in Mount Holyoke College.

THE Victoria University on Saturday last conferred on Sir George Gabriel Stokes, Bart., the honorary degree of D.Sc.

THE Rev. D. J. Thomas has been appointed Principal of the Home and Colonial Training College, Gray's Inn Road, and of the Highbury Training College for Secondary Teachers.

THE establishment of a fresh-water biological station at Hemlock Lake, under the direction of Prof. Charles W. Dodge, has been sanctioned by the Board of Trustees of the University of Rochester, U.S.A.

THE library building of the University of Iowa was on June 19 struck by lightning, and destroyed by fire. The physical laboratory was on the first floor of the building. The total loss is estimated at about £20,000.

AMONG recent appointments may be mentioned:—Dr. Brault, to be Professor of Tropical Diseases at Algiers; Prof. W. Th. Engelmann, of Utrecht, to be Professor of Physiology at Berlin, in place of the late Prof. du Bois-Reymond.

THE following resignations are announced:—Dr. James Woodrow from the presidency of South Carolina College; President Craighead and Profs. Tompkins and Wright from Clemson College; Dr. W. H. Hervey from the presidency of the Teachers' College, New York.

ACCORDING to *Science*, Prof. Edward L. Nichols, the President of the New York State Science Teachers' Association, has appointed a committee of nine to consider and report at the next annual meeting of the Association on the following topics:—"Science as an Entrance Requirement to Colleges," "Science Teaching in the Secondary Schools," "Nature Study in Primary Schools."

THE June issue of the *London Technical Education Gazette* contains particulars of various courses of science lectures which are to be given in the autumn and winter of this year at University and King's Colleges, and at the Battersea and South-West London Polytechnics. Many of the courses are quite free of charge, and as only a limited number of persons can be accommodated at some of them, early application is desirable.

UNDER the auspices of the American Society for the Extension of University Teaching, a summer meeting is being held at the University of Pennsylvania from July 6 to 30. *Science* announces that two lectures on "Mediæval Science" will be given by Prof. W. F. Magie, and lectures on "Forestry" and "Museums" will be delivered by Prof. J. T. Rothrock and Prof. W. P. Wilson respectively. In Psychology courses of lectures are announced by Prof. L. Witmer, Prof. J. M. Baldwin and Prof. E. B. Titchener. Conferences on the teaching of geography will be led by Profs. W. M. Davis and R. E. Dodge.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, June.—Hailstorm at Seaford, Sussex, May 30, 1897. It can be very rarely proved that a shower of hailstones as large as a hen's egg has fallen over a considerable area in England, but from letters received from various observers this is shown to have been the case during thunderstorms which occurred over the east of England on that day between the Isle of Wight and Lincoln. At Seaford several hailstones were picked up measuring 4½ inches round, and at Maidstone the stones were as large as walnuts; the noise there was so great that the services in nearly all the churches were interrupted.—Heavy rain at Port Elizabeth, Cape Colony, May 5, 1897. The amount measured between 8 a.m. and 1.30 p.m. was over 5 inches, and in three days 7·29 inches were measured.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 2.—New tertiary mammals found in Russia, by Mme. Marie Pavloff, with one plate (in French). The most important find is that of a bone which was identified as the lower end of the third metacarpus of *Anchitherium aurelianense*, Cuvier; thus being the first *Anchitherium* rest found in Russia. It comes from the neighbourhood of Nikolaieff, where it was found in a layer containing remains of *Mastodon borsoni*. The other remains belong to the Pliocene yellow "Balta Sands," and are: *Rhinoceros Schleiermacheri* (Kaup), *Capreolus cusanus* (Crois. and Job., *teste* Boyd Dawkins), and *Mastodon turicensis* (Schintz). They throw a new light on that interesting formation.—The reptiles of Europe, by Dr. J. Bedriaga, Part ii. *Urodela*. A most elaborate work (in German), containing full indexes of literature, synoptic tables for determination, and full detailed descriptions of the species (to be continued).—On the structure, &c., of the Nematocysts of Cœlenterata, by N. Iwanzoff, with two plates (in German, concluded).—Polar Land and Tropical Flora, by H. Trautschold (in German). Deichmüller having shown that the invariability of the rotation-period of the earth is not probable, and a variation in the position of the earth-axis having been proved, Prof. Trautschold enumerates the geological data, which render very probable that the position of the axis has been slowly displaced in geological times, and which could not be explained otherwise.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"Further Note on the Influence of a Magnetic Field on Radiation Frequency." By Prof. Oliver Lodge, F.R.S., assisted by Mr. Benjamin Davies.

Referring to a former communication of mine, on the subject of Zeeman's discovery, printed on page 513 of the *Proceedings* of the Royal Society for February 11 this year, vol. lx. No. 367, I wish to add an observation to those previously recorded, as I have recently acquired a concave Rowland grating ($3\frac{1}{2} \times 1\frac{1}{2}$-inch ruled surface, 14,438 lines to inch, being the one used by Mr. George Higgs), of which the spectra of the first and third orders on one side are very satisfactory.

It is said on page 513, "If the focussing is sharp enough to show a narrow, dark reversal line down the middle of each sodium line, that dark line completely disappears when the magnet is excited." With the greater optical power now available the dark reversal line is often by no means narrow, and though in some positions of the flame it does still tend to disappear or become less manifest when the flame is subjected to a concentrated magnetic field, the reason of its partial disappearance is that it is partially reversed again—*i.e.* that a third bright line, as it were, makes its appearance in the midst of the dark line, giving a triple appearance to each sodium line.

The following is a summary of the different appearances that may be seen according to the state of the flame and the strength of the field:—

At low temperature, and with the flame forward in the field, when each sodium line is sharp and single, magnetism widens it,

and with a little more power doubles it, causing a distinct dark line down its middle. The same effect occurs with lithium and thallium lines.

At higher temperature, and with the flame partially behind the field, when each sodium line appears as a broad hazy-edged double, magnetisation greatly widens the doubling, pushing asunder the bright components very markedly; stronger magnetisation reverses the middle of the widened dark band, giving a triple appearance; stronger magnetisation still reverses the middle once more, giving a quadruple appearance to the line. In every case a nicol, suitably placed, cuts off all the magnetic effect and restores the original appearance of the line.

The same thing is seen when salts of lithium or of thallium are introduced into the flame; and the components of the doubled red lines are more widely separated than the components of the doubled green lines, the effect being proportional to wave-length. The most interesting line to try was the red cadmium line, since this has been proved to be of specially simple constitution by Michelson. We have recently been able to get the cadmium spectrum well developed by means of a sort of spark arc between the magnet poles, maintained by an induction coil excited by an alternating machine, and we find that the magnetic doubling of the chief lines occurs in precisely the same way with the spark spectrum as with the flame spectrum, and that the red cadmium line behaves in the same way as the others. The magnetic effect is better seen from a direction perpendicular to the line of force when a nicol is interposed in the path of the light, but rotation of the nicol, through 90°, cuts it entirely off, accurately so where a small spark is the source of light.

June 17.—"Kathode Rays and some Analogous Rays." By Silvanus P. Thompson, F.R.S.

(1) The size of the kathodic shadow of an object depends upon its own electric state, as already found by Crookes (*Phil. Trans.*, 1879, Part ii. p. 648). If it is negatively electrified the shadow expands. If it is positively electrified the shadow contracts. The position, as well as the size of a kathodic shadow, may be affected electrostatically; the rays which cast the shadow being repelled from a neighbouring body if the latter is negatively electrified. In some cases the contraction of the shadow of a narrow object that is made positively electrical (anodic) may go so far that the luminous margins approach and even overlap, giving the appearance of a bright or negative shadow in place of a dark one. The enlargement of a shadow when the object is made kathodic, and the diminution of the shadow when the object is made anodic, both depend upon the degree of exhaustion of the tube; and both are augmented up to a certain point by raising the degree of exhaustion. The enlargement when the object is made kathodic vastly surpasses the diminution when the object is made anodic. Kathode rays are capable of being deflected electrostatically; being apparently strongly repelled from a neighbouring kathodic surface, and less strongly attracted towards a neighbouring anode. Two kathode beams from two small disc kathodes can cross through or penetrate one another without interfering with another.

(2) Objects protected by a non-conducting layer of glass do not at moderately low exhaustions, when made kathodic, repel or deflect kathode rays, and their shadow does not enlarge. But at a certain minimum exhaustion they suddenly exert an electrostatic deflection. Naked objects made kathodic deflect the kathode rays at all exhaustions.

(3) Kathode rays cannot be concentrated by reflection either from a non-conducting or a conducting surface, nor by passage through a metal tube which is itself negatively electrified.

(4) When kathode rays strike upon an internal metal target or anti-kathode there are emitted from the latter (both at exhaustions lower than suffice to produce Röntgen rays, and at exhaustions at which those rays are also produced) some internal rays resembling ordinary kathode rays in the following respects:—They produce a similar luminescence of the glass; they cast shadows of objects; they are susceptible of deflection both magnetically and electrostatically. But they produce no Röntgen rays where they fall upon the glass surface. They do not follow either the law of specular reflection, nor that of diffuse reflection, but are emitted from the anti-kathode surface apparently according to a similarly anomalous distribution to Röntgen rays, *i.e.* with nearly equal intensity, at all angles up to 90° with the normal. It is proposed to call these rays *para-kathodic* rays in contradistinction to the ordinary or *ortho-kathodic* rays. From the similarity of their distribution with that of the Röntgen rays it is inferred that the physical processes concerned in their production are identical. These para-kathodic rays are emitted from the anti-kathode both when the latter is made an anode, and when it is neutral or even made kathodic. From an anti-kathode there may proceed at one and the same time, and in one and the same direction para-kathodic rays and Röntgen rays, which, meeting an interposed object, may cast simultaneously two shadows—a para-kathodic shadow on the glass, and a Röntgen shadow on an external screen of barium platinocyanide. The former shadow can be deflected by a magnet, the latter cannot. The former shadow expands if the object is made kathodic; the latter does not.

(5) If thin metal screens are used to sift the kathode rays the luminescent phenomena change. The rays of least penetrating power appear to be most susceptible to magnetic and electrostatic forces. The various constituents of a heterogeneous kathode beam are emitted in various proportions at different degrees of exhaustion. In the kathode rays emitted at higher degrees of exhaustion there is a greater proportion of the less-deflectable rays. The least-deflectable rays are those which most readily penetrate through a perforated screen when that screen is itself negatively electrified.

When ordinary kathode rays fall upon a perforated screen which is itself made kathodic, or are attempted to be passed through a negatively electrified tube, there emerge beyond the screen or tube some rays, here termed *dia-kathodic* rays, which differ from the ortho-kathodic, and also from the para-kathodic rays. These dia-kathodic rays are not themselves directly deflected by a magnet. They show themselves as a pale blue cone or streak. Where they fall on the glass they do not excite the ordinary fluorescence of the glass. The dia-kathodic rays excite, however, a different or second kind of fluorescence; the tint in the case of soda-glass being a dark orange. Intervening objects in the beam or cone of dia-kathodic rays cast shadows. The orange fluorescence evoked on soda-glass by the dia-kathodic rays shows in the spectroscope the D lines of sodium only. The shadows cast by dia-kathodic rays are not deflected by the magnet, nor do they change their size when the object is electrified.

"Fifth Report to the Royal Society Water Research Committee." By H. Marshall Ward, F.R.S., Professor of Botany in the University of Cambridge. Presented to the President and Council, December 10, 1896.

The following conclusions show the principal points resulting from three years' study of the Bacterial Flora of the Thames:—

(1) Very many forms occur in the Thames, some of which are pathogenic under certain conditions.

(2) The "species" of the descriptive hand-books—principally medical—are frequently not species at all, in the botanical sense, but varieties, or growth-forms, the distinctive characters of which are not constant. These so-called species need revision and grouping around types, which may turn out to be the true species.

(3) The characters derived from the behaviour of colonies are not sufficient for the determination of species, and how far they may be employed in conjunction with other characters will only be elucidated by advances in our knowledge of the way the colonies are built up by the growing bacteria on the given media.

(4) The effects of definite changes in the environment on the media are of great importance, but have hardly been noticed as yet. Plate-colonies on gelatine, for instance, develop quite differently, according to the condition of the gelatine; so that a feeble and slow-growing bacterium produces colonies quite unlike those developed by the same species when vigorous and quickly growing, not only owing to its peculiarities of growth as a feeble form, but also because the gelatine has altered during the intervening period.

(5) The effect of changes of the environment on the growing organism itself is recognised as important.

(6) With especial reference to the Thames bacteria, the past history of the organism isolated from the river implies causes of variation. The river water is a poor nutritive medium, and the organism is exposed to great changes of temperature, light, movement, &c., during its sojourn therein. Consequently the time it has been in the river affects the behaviour of the organism when isolated, just as we know that a bacterium is affected by the previous conditions of its culture in other media. Hence two colonies on a plate may look very different, and yet belong to the same species, one being developed from a cell

that had been many days or weeks in the water, the other from one that had only been there a few hours. It may need weeks or months of cultivation under constant conditions to establish the identity of the two.

Linnean Society, May 24.—Anniversary Meeting, Dr. A. Günther, F.R.S., President, in the chair.—The report of the Librarian having been read, the President opened the chief business of the meeting, when the Fellows present proceeded to ballot for the President, Officers, and Council for the ensuing year. Scrutineers having been appointed, and the votes counted, the result was declared to be as follows:—President, Dr. Albert Günther, F.R.S.; Treasurer, Mr. Frank Crisp; Secretaries, Mr. B. Daydon Jackson and Prof. G. B. Howes. The President then delivered the annual presidential address, which, on the motion of Mr. C. B. Clarke, seconded by Prof. Stewart, it was resolved should be printed and circulated. The gold medal of the Society was formally awarded to Dr. J. G. Agardh, Emeritus Professor of Botany in the University of Lund, and, in consequence of his inability to receive it in person, was delivered on his behalf to his Excellency the Minister for Sweden and Norway, who made a suitable acknowledgment.

June 3.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. G. B. Howes exhibited specimens of the remarkable Crustacean *Anaspides tasmaniæ*, from the Hartz Lake, Huon district, Tasmania, which he had received from Mr. G. M. Thomson, its discoverer (see *Trans. Linn. Soc.*, Zool. [2] vol. vi. p. 287), together with a letter stating that the animal is now known from three localities. He directed attention to a recent monograph by Calman (*Trans. R. Soc. Edinb.*, vol. xxxviii. p. 787), in which the conclusion was drawn that the "Pod Shrimps" of the genera *Acanthotelson*, *Gampsonyx*, and *Palæocaris*, in respect to characters in which they are anomalous, agree with *Anaspides*, and that the four genera are probably to be referred to an ancient group of primitive Malacostraca. He remarked that he was disposed to agree with Calman's determination of the morphological value of the "first thoracic segment" of Thomson, and that he could confirm his statement that the peduncle of the flagellum of the antenna was but two-jointed.—The Rev. T. R. Stebbing, F.R.S., threw doubts upon the association claimed by Calman for *Acanthotelson*, and remarked that some Amphipods are known to agree with *Anaspides* in the possession of double epipodial lamellæ. The "ocellus" of Calman did not appear to him to occupy the position of an ocellus, and he thought it might possibly be a luminous organ.—Dr. G. D. Haviland, F.L.S., gave the substance of a paper on *Termites*, illustrated by lantern-slides, showing some of the more characteristic and remarkable forms of nests made by these insects, as well as figures of the insects themselves. A discussion followed, in which Mr. Saville Kent, the Rev. T. R. Stebbing, and the Rev. F. C. Smith took part; Mr. Kent exhibiting another series of lantern-slides illustrating the nests of Australian species.—Prof. T. Rupert Jones, F.R.S., communicated a paper by himself and Mr. F. Chapman on the genus *Ramulina*, forming the second part of a paper of which the former portion, on the tubulose and fistulose Polymorphinæ, has been already published (*Linn. Soc. Journ.*, Zool. xxv. p. 496).—The Secretary communicated a paper, by Mr. E. C. Horrell, on the number of sterigmata and spores in *Agaricus campestris*.

June 17.—Dr. A. Günther, F.R.S., President, in the chair.—Dr. D. H. Scott, F.R.S., exhibited original preparations by Prof. Ikeno and Dr. Hirase, of Tokio, Japan, illustrating their discovery of spermatozoids in two Gymnospermous Phanerogams, namely, *Ginkgo biloba* and *Cycas revoluta* (*cf.* Bot. Centralblatt, Bd. lxix. Nos. 1-2, 1897, and Annals of Botany, June, 1897). The slides showed the spermatozoids while still in the pollen-tube, before the commencement of active movement. In the case of *Ginkgo* one section showed the two male generative cells, closely contiguous and enclosed in the pollen-tube. The general structure resembles that in many other conifers at the same stage, *e.g. Juniperus virginiana* and *Pinus silvestris* (Strasburger, Hist. Beiträge, iv. pl. 2). In *Ginkgo*, however, each generative cell showed a distinct spiral coil, situated in each cell, on the side remote from its neighbour. Another preparation of *Ginkgo* showed a series of sections across the micropyle, passing through a pollen-tube and its generative cells, the plane of section being in this case approximately parallel to the surface of contact of these two cells, through which four of the sections passed. In the two terminal sections of this series the spiral coil was clearly shown, consisting of about three windings. The spiral is connected with the nucleus of the cell, but whether it is itself of nuclear or cytoplasmic origin is not certain. In the preparation from *Cycas revoluta*, several pairs of generative cells were shown; in some cases the pollen-tube enclosing them was intact. The spiral coils in some of the generative cells were surprisingly clear, consisting of about four windings. A distinct striation was visible in connection with the coil, probably indicating the presence of the numerous cilia described by the Japanese discoverers. The facts admit of no other interpretation than that given by these authors, namely that in both *Ginkgo* and *Cycas* each generative cell gives rise to a spiral spermatozoid; the latter by its own movements (actually observed by Dr. Hirase in the case of *Ginkgo*) no doubt travels from the end of the pollen-tube to the female cell. In a discussion which followed on this highly important subject, Dr. W. T. Thiselton Dyer, C.M.G., Mr. W. Carruthers, F.R.S., Prof. E. Ray Lankester, F.R.S., Prof. Howes, F.R.S., and the President took part.—Mr. T. B. Blow exhibited and described a curious case of protective mimicry in *Asparagus albus*, which drew forth criticism by Mr. H. Groves and the President.—Mr. J. E. Harting exhibited and made remarks upon specimens of *Nestor productus* and *Nestor norfolcensis*, from the Derby Museum, Liverpool, lent for exhibition by Dr. H. O. Forbes. The specimen of *Nestor norfolcensis* was of especial interest, from the remark of Count Salvadori (Brit. Mus. Cat. Parrots, xx. p. 10) that this bird is now extinct and is only known from Latham's description (Gen. Hist. Birds, 1822, ii. p. 171), and from the description and figure of the head published by von Pelzeln (Sitzb. k. Akad. Wiss., 1860, xli. p. 322) from a drawing by Ferdinand Bauer, who had visited Norfolk Island where the bird was found. With regard to *Nestor productus*, it appeared (1) that the species underwent a change of plumage analogous to that of the Crossbills: (2) that the description given by Latham applied to a more adult bird than that now shown; (3) that the result of a comparison of the two skins exhibited and the dimensions of the wings, tarsi, and feet, rendered it doubtful whether the two forms were specifically distinct, the slight variations observable in the colouration being such as might reasonably be attributed to age or sex.—Mr. Miller Christy read a paper on *Primula elatior*, Jacq., in Britain. He remarked that this widely-distributed continental plant, though figured accidentally in "English Botany" in 1799, was not really detected in Britain till 1842, to which time the totally distinct hybrid Oxlip (*P. acaulis* × *veris*) was, by British botanists, confused with, and mistaken for it, as is still frequently the case. In Britain, *P. elatior* occupies a sharply defined area, divided by the valley of the Cam, with only two outlying localities, so far as Mr. Christy could ascertain. This area covers the two most elevated and unbroken portions of the boulder clay district, the loams and gravels of the river-valleys and the chalk being entirely avoided. The boundary-lines (some 175 miles in length) which had been traced by Mr. Christy with precision were, in consequence, very sinuous. They enclosed together about 470 square miles, over which area the Oxlip flourishes in immense abundance in all old woods and some meadows; while the Primrose (which grows all around) is entirely absent. Along the dividing line between the two, which is very sharply defined, hybrids are produced in great abundance. On the other hand, the Cowslip (which grows both around and throughout the Oxlip area) very rarely hybridises with it. Mr. Christy believed that the Primrose was, in this country, gradually hybridising the Oxlip out of existence. He then noticed a rare single-flowered variety of *P. elatior*, which he proposed to call var. *acaulis*, and several aberrations, showing upon the screen photographic views of these and of the hybrids, as well as a map of the distribution of the Oxlip in Britain. In a discussion which followed, Mr. C. B. Clarke, F.R.S., and Sir John Lubbock, Bart., M.P., confirmed the accuracy of Mr. Christy's observations.—On behalf of Mr. A. D. Michael, the Zoological Secretary read a report on the *Acari* collected by Mr. H. Fisher, naturalist of the Jackson-Harmsworth Polar Expedition, at Cape Flora, Northbrooke Island, Franz Josef Archipelago, in 1896. The collection had been formed under great difficulties, and consisted of five species, two of which (*Erethræus Harmsworthi* and *Oribata Fisheri*) were regarded as new to science.—Sir John Lubbock, Bart., M.P., F.R.S., communicated the substance of a paper entitled "Further observations on Stipules," in continuation of a former paper communicated by him to the Society on March 18 last.

The present paper, which was illustrated by diagrams, has reference, *inter alia*, to the Ash, Hop, and two species of Pea (*Lathyrus grandiflora* and *L. pratensis*). Mr. W. Carruthers, F.R.S., in commenting upon this paper, expressed the satisfaction which he was sure would be felt by botanists at the way in which the author was carefully working out details in the life-history of British plants, and in that respect conforming to the spirit of the charter of the Society which expressly defined the object of its formation to be "the cultivation of the science of natural history in all its branches, and more especially of the natural history of Great Britain and Ireland."—Prof. Conway Macmillan, of the University of Minnesota, communicated the principal points of a paper on minor tension-lines between plant-formations.

PARIS.

Academy of Sciences, June 28.—M. A. Chatin in the chair.—The President announced to the Academy the loss it had sustained by the death of M. Schützenberger, Member of the Chemical Section.—On the integration of the equation $\Delta u = F(u, x, y)$, by M. Émile Picard.—On uniform quadruply periodic functions of two variables, by M. Émile Picard.—On the rotatory parts of the transversal components of the velocity in a permanent flow gradually varied, by M. J. Boussinesq.—M. de Lapparent was nominated as Member in the Section of Mineralogy, in the place of the late M. Des Cloizeaux.—On psoriasis and its relations with syphilis, by M. F. Bouffé. The injection of orchitine appears to be specific as a cure for psoriasis. The latter frequently masks the symptoms of syphilis. In the cases cited, if the treatment had been sufficiently prolonged, there was no return of the disease.—On the treatment of cancer, and of several infectious diseases by ozone, by M. Charles Chardin.—On the causes of differences of quality in harmonic chords, by M. Bourcoud.—Observations on the sun, made at the Observatory of Lyons with the Brunner equatorial, during the first quarter of 1897, by M. J. Guillaume. A tabulated statement of observations on sun-spots and faculæ.—On the geodesic lines of oppositely curved surfaces, by M. Hadamard.—On the enumeration of primitive groups of which the degree is below 17, by M. J. A. Miller.—On the determination of the integrals of certain non-linear partial differential equations by their values on a closed surface, by M. E. Le Roy.—On the permanent deformations of metals, by M. G. A. Faurie.—Influence of the intensity upon the pitch of a sound, by M. André Broca. If the intensity of a sound decreases, the note goes up, even though the period of vibration remains the same. The effects are small, and in the experiments described amount to about $\frac{1}{5}$ of a tone.—Researches on nickel-steels. Magnetic properties and permanent deformations, by M. C. E. Guillaume. The effect of temperature upon the magnetic properties of the nickel-steels was first studied, and it was found that these alloys could be divided into two classes, those containing from 0 to 25 per cent of nickel, for which the effects produced by heat were irreversible, whilst in the second class, containing higher percentages of nickel, the effects were reversible. The permanent changes of length set up in these alloys are of the same order as those in the hard glass used in thermometers.—The sulpho-antimonites of silver, by M. Pouget. The salts KAg_2SbS_3 and Ag_3SbS_3 are described. K_2AgSbS_3 could not be prepared.—On the function of manganese in certain oxidations, by M. Ach. Livache. A discussion of the action of manganese salts in quick-drying oils.—The colour of the phosphorescence of strontium sulphide, by M. José Rodriguez Mourelo. The phosphorescence depends largely upon the nature of the impurities present, and hence upon the method of preparation. The sulphide produced by the action of sulphur upon strontianite at a red heat gives the finest green colour.—Observations on the molecular volumes of several crystallised carbohydrates at 0°, by M. Pionchon. An extension of an observation of Joule and Playfair to the effect that the molecular volumes of cane-sugar and milk-sugar were exactly equal to the volume occupied in the state of ice, of the water of which this mass contains the elements. The same relations hold approximately for xylose, glucose, levulose, mellitose and raffinose.—Trioxymethylene and paraformaldehyde, by M. Delépine. The heats of formation of trioxymethylene and paraformaldehyde from its elements were determined, and also the heat of solution of the former in water.—On some combinations of phenylhydrazine with metallic iodides, by M. J. Moitessier. The compounds $ZnI_2.2(C_6H_5.N_2H_3)$, $ZnI_2 5(C_6H_5.N_2H_3)$, $CdI_2.2(C_6H_5.N_2H_3)$, $MnI_2.2(C_6H_5.N_2H_3)$, and $NiI_2 6(C_6H_5.N_2H_3)$ are described.—On the combination of metallic salts with organic bases homologous with aniline and their isomers, by M. D. Tombeck.—On the action of acetylene on silver nitrate, by M. G. Arth.—On the tetrameric regeneration of the tarsus of the Phasmidia, by M. Edmond Bordage.—The *N'djembo* the caoutchouc plant of Fernan-Vaz, by M. Henri Jumelle. The plant is described and named *Landolphia Foreti*. It is distinguished from *Landolphia owariensis*, among other points, by the superior quality of the caoutchouc produced from it.—A new remedy against mildew and black rot, by M. Gaston Lavergne. The mixture proposed consists of copper sulphate (500 gr.), black soap (1000 gr.), and water (100 litres).—Observation on a French meteorite, the fall of which (at Clohars in 1822) was unnoticed, by M. Stanislas Meunier.—The nerves of the heart and thyroid gland, by M. E. de Cyon.—Researches on the ostioles of the mucous membranes, by M. J. J. Andeer.—Effects of a hailstorm, by M. A. Forel. This hailstorm of June 2, at Morges, was remarkable for the duration of the fall of hail, more than ten minutes; the great electrical disturbances, the lightning being almost continuous; the magnitude of the hailstones, 5 to 6 cm. in length; and the peculiar structure of some of the pieces of ice.

BOOK, PAMPHLETS, and SERIALS RECEIVED.

BOOK.—The Chlorination Process: E. B. Wilson (Chapman).

PAMPHLETS.—Hints to Meteorological Observers: W. Marriott, 4th edition (Stanford).—The Fallacy of Marx's Theory of Surplus Value: H. Seymour (Murdoch).

SERIALS.—Den Norske Nordhavs-Expedition, 1876–1878, xxiv. (Christiania).—Synoptical Flora of North America, Vol. 1, Part 1, Fasc. 2 (New York, American Book Company).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1897, No. 5 (Bruxelles).—Journal of the Royal Agricultural Society of England, June (Murray).—Zeitschrift für Physikalische Chemie, xxiii. Band, 2 Heft (Leipzig, Engelmann).—National Review, July (Arnold).—Economic Journal, June (Macmillan).—Scribner's Magazine, July (Low).—Fortnightly Review, July (Chapman).—Geographical Journal, July (Stanford).

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THURSDAY, JULY 15, 1897.

THE ANCIENT VOLCANOES OF BRITAIN.

The Ancient Volcanoes of Britain. By Sir Archibald Geikie, F.R.S., Director-General of the Geological Survey. Vol. I., pp. xxiv. + 477; Vol. II., pp. xvi. + 492. (London: Macmillan and Co., Ltd., 1897.)

THE Edinburgh school of geology, when of old it formulated the theory of existing causes of terrestrial change, established the fundamental principle of modern geological science. Thanks to this school, men learnt how rocks were formed, how the strata of the earth's crust were built up, how slow had been the evolution of the continents and oceans, and how important is the conception of time in regard to the past history of the globe. The brilliant representative of this illustrious school who has recently published a history of the volcanoes of Great Britain, sets forth in this remarkable treatise the great features in the volcanic history of the earth, and establishes the principles which will henceforth guide geologists in the study of the massive crystalline rocks.

From the remotest times there have existed on the surface of the globe volcanoes essentially similar to those now active. Such is the doctrine which Sir Archibald Geikie maintains. He has proved the uniformity of the phenomena and of the volcanic products throughout the geological past. He has indicated the cycles of differentiation among the magmas, and their recurrence in successive ages. He has shown how the sequence and structure of ancient eruptive rocks are to be determined.

The geological historian who shall hereafter record the stages in the progress of our knowledge regarding what may be termed fossil volcanoes, will attribute their first discovery to Guettard and Desmarest; their analysis to Sorby, to the German petrographers, and to Fouqué and Michel Lévy (to whom the present work is dedicated); and their synthesis to Sir Archibald Geikie, who has resuscitated and reconstructed the old dismantled volcanoes, buried under the geological formations of Great Britain.

The author, in a preface dealing with the history of discovery in the domain of volcanic geology, introduces his subject in the following sentences.

"In no department of science is the slow and chequered progress of investigation more conspicuous than in that branch of geology which treats of volcanoes. Although, from the earliest dawn of history, men had been familiar with the stupendous events of volcanic eruptions, they were singularly slow in recognising these phenomena as definite and important parts of the natural history of the earth. Even within the present century, the dominant geological school in Europe taught that volcanoes were mere accidents. A juster appreciation of the nature of the earth's interior was needed, before men could recognise that volcanic action had once been vigorous and prolonged in many countries, where no remains of volcanoes can now be seen."

"To France, belongs the merit of having laid the foundations of the systematic study of ancient volcanoes. As far back as the year 1752, Guettard recognised that the Puys of Auvergne were volcanic cones that had poured forth streams of lava. But it was reserved to Desmarest twelve years later to examine the question in detail, and to establish the investigation of former volcanic action upon a broad and firm basis of careful observation and sagacious inference. He discovered that the volcanoes of Central France were not all of one age, but had made their appearance in a long series, whereof the individual members became less perfect and distinct in proportion to their antiquity." "While these fruitful researches were in progress in France, others of hardly less moment were advancing in Scotland. Hutton, as a part of his immortal 'Theory of the Earth,' had conceived the idea that much molten material had been injected from below into the terrestrial crust, and he had found many proofs of such intrusion among the rocks of his native country. His observations, confirmed and extended by Playfair and Hall, and subsequently by Macculloch, opened up the investigation of the subterranean phases of ancient volcanic action" (Preface, pp. vii.-viii.).

From the peculiarly favourable structure of the country, Britain has been enabled to make many important contributions to the investigation of the subject. De la Beche, Murchison and Sedgwick led the way in recognising, even among the most ancient stratified formations of England and Wales, the records of contemporaneous volcanoes and their subterranean intrusions.

A new stage in the history of volcanic geology was entered when Sorby introduced the method of microscopic examination of rocks by means of thin slices. Petrographical investigation was thereby enabled to keep pace with stratigraphical research. The rocks of the whole globe have been made to pass through the German laboratories, and thus precise knowledge has been obtained regarding the mineralogical composition and structure of the rocks, and light has been thrown on the true principles of their classification. In France, Fouqué and Michel Lévy, studying volcanic rocks both in the field and in thin sections, have been able to reproduce the principal types artificially in their laboratory.

In Sir Archibald Geikie's volumes the study of ancient volcanic rocks now emerges from the laboratory, and is prosecuted under the broad sky among the crags, the shores, and the isles. Not that the minute description of internal structure or of chemical and mineralogical composition is neglected by him; but the rocks are no longer looked at as they are in themselves: their chief value is now sought in their association as parts of a connected volcanic history. A dyke is only noticed when its description allows it to be connected on the one side with a subterranean reservoir, and on the other with its superficial display of lavas or fragmental discharges. The rocks are studied as much from the point of view of their origin as from that of their composition, and their structure is shown to be in relation to some determinate part of a volcanic group. All that has been done, all that has been said in regard to these questions, will be found summed up in Sir Archibald's work, while his masterly exposition of the history of volcanoes from the earliest times down to our own day is enhanced with ingenious conclusions respecting the nature and causes of volcanic action.

The fossil volcanoes reveal no craters. No trace of their original cones has survived to our time, save in some exceptional cases where they have been entombed under lavas, or have been preserved under other accumulations. These and other characteristics con-

stitute difficulties in the study of ancient volcanic action. But they have not proved insuperable. Such has been the progress of this study, that it has already thrown light on the structure and mechanism of the active volcanoes of the present day. Thus a comparison of the pas with the present may enable us to arrive at some adequate conception of the nature and history of volcanoes in the geological history of the globe.

"In this research," as Sir Archibald Geikie remarks, "it is obvious that the presently active volcano must be the basis and starting-point of inquiry. At that channel of communication between the unknown inside and the familiar outside of our globe, we can watch what takes place in times of quiescence or of activity. We can there study each successive phase of an eruption, measure temperatures, photograph passing phenomena, collect gases and vapours, register the fall of ashes or the flow of lavas, and gather a vast body of facts regarding the materials that are ejected from the interior, and the manner of their emission.

"Indispensable as this information is for the comprehension of volcanic action, it obviously affords after all but a superficial glimpse of that action. We cannot see beyond the bottom of the crater. We cannot tell anything about the subterranean ducts, or how the molten and fragmental materials behave in them. All the underground mechanism of volcanoes is necessarily hidden from our eyes. But much of this concealed structure has been revealed in the case of ancient volcanic masses, which have been buried and afterwards upraised and laid bare by denudation.

"In yet another important aspect modern volcanoes do not permit us to obtain full knowledge of the subject. The terrestrial vents, from which we derive our information, by no means represent all the existing points of direct connection between the interior and the exterior of the planet. We know that some volcanic eruptions occur under the sea, and doubtless vast numbers more take place there of which we know nothing. But the conditions under which these submarine discharges are effected, the behaviour of the outflowing lava under a body of oceanic water, and the part played by fragmentary materials in the explosions, can only be surmised. Now and then a submarine volcano pushes its summit above the sea-level, and allows its operations to be seen, but in so doing it becomes practically a terrestrial volcano, and the peculiar submarine phenomena are still effectually concealed from observation.

"The volcanic records of former geological periods, however, are in large measure those of eruptions under the sea. In studying them we are permitted, as it were, to explore the sea-bottom. We can trace how sheets of coral and groves of crinoids were buried under showers of ashes and stones, and how the ooze and silt of the sea-floor were overspread with streams of lava. We are thus, in some degree, enabled to realise what must now happen over many parts of the bed of the existing ocean.

"The geologist who undertakes an investigation into the history of volcanic action within the area of the British Isles during past time, with a view to the better comprehension of this department of terrestrial physics, finds himself in a situation of peculiar advantage. Probably no region on the face of the globe is better fitted than these islands to furnish a large and varied body of evidence regarding the progress of volcanic energy in former ages" (vol. i. pp. 5–6).

Towards the close of his second volume, after adducing in full detail the volcanic records of his native country, the author remarks that

"A review of the geological history of Britain cannot but impress the geologist with a conviction of the essential uniformity of volcanism in its manifestations since the early beginnings of geological time. The composition and structure of the materials erupted from the interior have remained with but little change. The manner in which these materials have been discharged has likewise persisted from the remotest periods. The three modern types of Vesuvian cones, Puys and fissure-eruptions, can be seen to have played their parts in the past as they do to-day."

After an introductory series of chapters dealing with general principles of investigation and interpretation, the work enters upon a detailed description of the volcanic phenomena of the successive geological periods, beginning with the most ancient.

"Among the earliest igneous masses of which the relative geological date can be fixed are the dykes which form so striking a system among the Archæan rocks of the north-west of Scotland, and show how far back the modern type of volcanic fissures and dykes can be traced. No relic, indeed, has survived of any lavas that may have flowed out from these ancient fissures, but so far as regards underground structure, the type is essentially the same as that of the Tertiary and modern Icelandic lava-fields" (vol. ii. pp. 470–471).

The early Palæozoic volcanoes formed cones of lava and tuff comparable to those of such vents as Vesuvius and Etna. As illustrations of the Vesuvian type in the volcanic history of Britain, the author refers to the great Lower Silurian Volcanoes of Cader Idris, Arenig, Snowdon and the Lake District, and to the Old Red Sandstone volcanoes of Central Scotland. In the Lake District the pile of material ejected during Lower Silurian time was at least 8000 or 9000 feet thick. In the Old Red Sandstone basins of Central Scotland there were more than one mass of lavas and tuffs thicker than those of Vesuvius.

The Carboniferous volcanoes were not only abundant and persistent in Scotland, but they attained there a variety and development which give their remains an altogether exceptional interest in the study of volcanic geology. They are referable, from their characters and their age, to two different types, *Plateaux* and *Puys* (vol. i. p. 364).

In the *Plateau-type*, the volcanic materials were discharged over wide tracts of country, so that they now form broad tablelands or ranges of hills, reaching sometimes an extent of many hundreds of square miles and a thickness of more than 1000 feet. Plateaux of this character occur within the British area only in Scotland where they are the predominant phase of volcanic intercalations in the Carboniferous system, and are eminently characteristic of the earliest portion of that period. This *Plateau* or *Fissure-type* is, among modern volcanoes, best developed in Iceland. In that island, during a volcanic eruption, the ground is rent open by long parallel fissures, only a few feet or yards in width, but traceable sometimes for many miles, and descending to an unknown depth into the interior. From these fissures lava issues—in some cases flowing out tranquilly in broad streams from either side, in other cases issuing with the discharge of slags and blocks of lava which are piled up into small cones set closely together along the line of the rent. By successive discharges of lava from fissures, or from vents opening on lines of fissure, wide plains may be covered with a floor of rock made up of horizontal beds.

The author shows that, after the beginning of the Carboniferous Limestone period, when eruptions of the

plateau-type had generally ceased, volcanic activity showed itself over the area of the British Isles in a different guise, both as regards the nature of its products and the manner and scale of their discharge (vol. i. p. 414). Instead of widely extended lava-sheets and tuffs, piled above each other sometimes to a thickness of many hundred feet, and stretching over hundreds of square miles, another phase of volcanism presented itself, where scattered groups and rows of *Puys*, or small volcanic cones, threw out, in most instances, merely tuffs, and these often only in trifling quantity, though here and there their vents also poured forth lavas, and gradually piled up volcanic ridges which, in a few cases, almost rivalled some of the plateaux. The evidence for these less vigorous manifestations of volcanic activity is furnished (1) by layers of tuff and sheets of basaltic-lavas intercalated among the strata that were being deposited at the time of the eruptions; (2) by necks of tuff, agglomerate, or different lava-form rocks that mark the positions of the orifices of discharge; and (3) by sills, bosses, and dykes that indicate the subterranean efforts of the volcanoes. The comparatively small thickness of the accumulations usually formed by these vents, heir extremely local character, the numerous distinct horizons on which they appear, and the intimate way in which they mingle and alternate with the ordinary Carboniferous strata, are features which at once arrest the attention of the geologist, presenting, as they do, so striking a contrast to those of the plateaux.

In a vast number of ancient volcanic vents, no trace can be discovered of their connection with any fissure in the earth's crust (vol. i. p. 53). Such fissures may, indeed, exist underneath, and may have served as passages for the ascent of lava to within a greater or less distance from the surface. But it is established in these volumes that volcanic energy has the power of blowing out an opening for itself through the upper part of the crust without the existence of any visible fissure there. What may be the limits of depth at which this mode of communication with the outer air is possible we do not yet know. They must obviously vary greatly according to the structure of the terrestrial crust on the one hand, and the amount and persistence of volcanic energy on the other. But where the thickness of rock above the end of the fissure is not too great, the expansive energy of the vapours absorbed in the magma may overcome the resistance of that cover, and blow out an orifice by which the volcanic materials can reach the surface. In an ordinary volcanic orifice the ground-plan of the neck is usually irregularly circular or elliptical.

The discharge of explosive vapours was sometimes the first and only effort of volcanic energy. Generally, however, fragmentary volcanic materials were ejected, and cones of tuff were formed; or, if the eruption was more vigorous, lava was poured out. Towards the close of a volcanic period, the vents were gradually choked up with the fragmentary materials that were ejected from, and fell back into them. When the vents were plugged up by the consolidation of fragmentary matter, or the uprise of lava in them, the final efforts of the volcanoes led to the intrusion of *sills* and *dykes*, not only into the rocks beneath the volcanic sheets, but also, in many instances, into at least the older parts of these sheets themselves. The size and extent of the *sills* may thus be a record of the intensity of this latest phase of the volcanic eruptions.

The chief products of the Carboniferous volcanoes are basic rocks, dolerites, and basalts, with andesites; they are somewhat more acid in the necks, where are found diabases, trachytes, and phonolites. The Puy lavas are generally more basic than the lavas of the plateaux.

The Permian volcanoes were the last of the long Palæozoic series, and, so far as we yet know, the whole of the Mesozoic periods, within the area of Britain, were absolutely unbroken by a single volcanic eruption. It was an era of geological calm, during which the Triassic, Jurassic and Cretaceous formations were slowly accumulated over the larger part of Europe. The stratigraphical quietude was not, indeed, unbroken. The widespread subsidence of the sea-bottom was interrupted here and there by important upheavals, and considerable geographical changes were in process of time accomplished. But, save in one or two widely separated areas of Europe, there were no active volcanoes over the whole continent.

After the enormous interval represented by the whole of the Mesozoic and the earlier part of the Tertiary formations, a time of disturbance arose once more, and a surface of 40,000 square miles was covered in the north-west of Britain by great basalt-floods. The whole of these latest volcanic manifestations were comprised within the earlier (Oligocene and, perhaps, early Miocene) part of older Tertiary time.

The first indications of Tertiary volcanic energy in the north-west of Europe were displayed in the formation of numerous parallel fissures extending in the British Isles in a general north-westerly direction. Between the walls of these opened fissures a basic magma rose and solidified, thus constituting the innumerable dykes of the region. Sometimes the magma reached the surface of the ground, and streaming forth there formed the successive sheets of basalt in the great plateaux. In some instances, as in modern Icelandic eruptions, the lava may have issued immediately from the fissures; in others its rise has been accompanied with the formation of small cones along the line of a chasm. During a tolerably protracted period, basic and intermediate lavas (basalts, dolerites, andesites, and trachytes) continued to be poured out, together with possibly an occasional outflow of rhyolite. These eruptions took place from many points, and not from great central volcanoes like Vesuvius. The result of their operations was to bury under more than 3000 feet of volcanic materials the broad valley between the mainland of Scotland and the chain of the Outer Hebrides. This long series of eruptions is shown to have been subaerial by the terrestrial relics—plants, insects, river-beds and lake-bottoms preserved under and between the lavas. Gradually, as the pile of volcanic material grew in thickness, the magma was less frequently ejected to the surface, but it insinuated itself underneath to form there sills or intrusive sheets.

The second stage in the Tertiary volcanic history is revealed by the great bodies of amorphous and banded gabbro which form so prominent a feature in the Inner Hebrides. These eruptive masses have disrupted the

lavas of the plateaux which are more or less metamorphosed around them, and are traversed by a fringe of finer-grained sills and veins of dolerite, gabbro, troctolite, picrite, &c., which have often insinuated themselves between the sheets of the plateau-basalts. The coarse-grained and banded gabbros may have consolidated at some depth; at least nothing is yet certainly known of their superficial equivalents.

The third stage of activity, probably long posterior to the second, likewise furnishes no evidence of any superficial ejection. It is recorded by a series of markedly acid rocks—obsidians, felsites, rhyolites, porphyries, granophyres, and granites. These rocks form huge conical hills, which in outward aspect recall the trachytic Puys of Auvergne. They traverse alike the plateau-basalts and the bosses of gabbro, into which they send many dykes and veins. They also project numerous thick sills into the formations lying underneath. The rocks around these acid protrusions have been greatly metamorphosed, while the granophyres and granites have in turn undergone considerable change in composition from having caught up and assimilated sometimes a fourth of their bulk of basalt or gabbro.

After the uprise of the granophyres with their surrounding network of felsitic dykes and veins, a new ascent of basic material manifested itself, recalling that of the earliest basalt-dykes, but on a minor scale. The dykes then formed cut all the other members of the volcanic series, including the granophyres. No trace remains of any superficial discharges connected with these latest dykes. If they ever gave rise to outflows of lava, these have long since disappeared in the vast denudation which the Tertiary volcanic rocks have undergone.

The latest eruptions of North-Western Europe, forming the Tertiary volcanic series, are shown by Sir Archibald Geikie to have far exceeded in area, and possibly also in bulk of material discharged, all the eruptions that had preceded them in the geological record.

We learn further that neither in their forms or products, nor by their extent and vigour, did the volcanic manifestations of the successive ages of the geological past materially differ from those of the present time. There is assuredly no evidence that volcanic energy has gradually waned since the dawn of geological history.

A consideration of the distribution of the volcanic rocks in time shows not only how singularly uniform the course of volcanic activity has been, but that there is no evidence of the cessation of any of the broader petrographical types during geological history. Quite as much variety may be observed among the erupted materials of Tertiary time in Britain as among those of the early ages, when the earth was younger and its volcanic vigour might be supposed to have been greater and more varied than it is now.

From the evidence detailed in these volumes, it appears that the sequence from basic to acid discharges was on the whole characteristic of each eruptive period. It is obvious however, the author observes, that as the protrusions of successive periods took place within the same limited geographical area, the internal magma during the interval between two such periods must in some way have been renewed as regards its constitution, for when, after long quiescence, eruptions began once more, basic lavas appeared first, and were eventually followed by acid kinds.

Various opinions have been propounded as to the cause or causes of the differentiation observable in erupted masses, but none of them are entirely satisfactory. We must await the results of further exploration in the field and of continued research in the laboratory.

What appears to have taken place within a subterranean molten magma which has been propelled into the earth's crust as a boss or laccolite, with or without a connected system of dykes, may possibly be made to throw some light on the remarkable changes in the characters of lavas successively erupted from the same vent during the continuance of a volcanic cycle. Whether or not any such process of differentiation can be proved to take place within a subterranean volcanic reservoir, the sequence of erupted lavas bears a curious resemblance to the order in which the constituents of some large bosses succeed each other from margin to centre (vol. i. p. 92).

Sir Archibald Geikie has written the history of the ancient volcanoes of Britain in a series of attractive chapters, which he has illustrated with more than four hundred sketches, photographs and maps. But the fine work with which he has enriched science is much more than a detailed description of the crystalline rocks of his own country. He elucidates their structure and arrangement,.and explains thereby their history. He rises from a consideration of facts to a discussion of the cause of volcanic phenomena. He makes the extinct volcanoes bear their testimony in favour of the uniformity and unity of the laws of nature. His work will remain one of the monuments of our time, establishing for the future the conception of the continuity of volcanic phenomena from the earliest periods, and, so far as the geological records go, demonstrating that the interior of our planet has reacted on its exterior in the same way and with the same results. CHAS. BARROIS.

AMERICAN MATHEMATICS.

Higher Mathematics: a Text-book for Classical and Engineering Colleges. Edited by Mansfield Merriman and Robert S. Woodward. Pp. xi + 576. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THIS is a style of mathematical treatise to which we are not accustomed in this country, from the luxury of the print and size of page, as well as for the refreshing novelty and interest of the contents.

Till recently, it was thought that the study of mathematics was not likely to flourish in America, as *trop vieux jeu* by the side of the new physical and biological sciences. To-day, however, it is the American student who is the most enthusiastic follower of recent mathematical development, while we in this country are being left far behind.

The words on the title-page—A Text-book for Classical and Engineering Colleges—the equivalent of our own—For Schools and Colleges—is not, however, taken, as with us, to be the rendering of *In usum Delphini;* all human interest arising from the application of theory has not been carefully eliminated from the pages, as

likely to confuse or excite the mind of the student; on the contrary, the various contributors insert carefully chosen appropriate illustrations as the best means of elucidating the difficulties of the abstract theory. With us the spirit of the schoolmaster is too much abroad in our mathematical writings; it has even been objected that these illustrations tend to obscure a subject, as it were, with the smoke of its own guns: a musty simile in these days of smokeless gunpowder.

Thus, for instance, the solution of a quintic equation is presented as required for the determination of the supply of a water-main (p. 13); very vulgar this, our college professor will say. So, too, the intuitive reasoning of a graphical procedure with an appropriate diagram has been freely employed to replace the tedious and unconvincing procession of formulas which impede the progress of our own students. A mention of M. Félix Lucas's electrical determination of the roots, real and imaginary, might well have found a place here.

Each of the eleven chapters of the book is undertaken by a different writer—Chapter i., on the Solution of Equations, by Mansfield Merriman; and Chapter ii., on Determinants, by Laenas Gifford Weld; both complete and original in their way.

The treatment, in Chapter iii., of Projective Geometry, by George Bruce Halsted, is very bright and stimulating; this is a subject ignored in our own mathematical curriculum.

The two forms of spelling "centre" and "center," appear on the same page (95); the second is, of course, phonetically correct, as the English pronunciation always inverts the liquid and the vowel in the French spelling, here and in all similar words.

Chapter iv. is on Hyperbolic Functions, by James McMahon. Our scholastics look upon this subject as a temporary fad, which has not come to stay; however, electricians find them indispensable, and many elegant electrical applications, among others equally important, of mechanical and astronomical interest, such as catenaries, loxodromes, charts, conjugate functions, will be found collected here.

The long form of these functions, cosh, sinh, tanh, . . . has been retained, with a suggestion that the ugly sounds they suggest should be avoided by pronouncing them *h*-cosine, *h*-sine, *h*-tangent, &c. But the modern continental practice is to abbreviate the symbols to ch, sh, th, pronouncing only the letters *c-h*, *s-h*, *t-h*, as with the Elliptic Functions; so also for their inverse functions, ch^{-1}, sh^{-1}, th^{-1}, employed here, for their obvious advantages in integration. A well-arranged table concludes this chapter; we miss, however, Bernoulli's numbers in their proper place in the expression of $\tan x$, $\mathrm{th}\, x$. . . .

Prof. Byerley, of Harvard, contributes Chapter v., on Harmonic Functions. When his genial treatise on Fourier's Series and Harmonic Analysis made its appearance, some four years ago, it was welcomed by all physicists as the long-desired manual, which placed this subject before them in an intelligible manner, devoid of artificial obstacles and impediments. Unfortunately the treatise fell into the hands of mathematical critics, who could see little merit in the book, because it passed over in silence the tedious, and useless, arguments concerning the legitimacy of the expansions. If an electrician is to employ a Fourier Series, he will content himself with the first two or three terms of the series; just as the calculator of mathematical tables will not, for practical purposes, employ more than three, or four terms at most, in Taylor's Series. But where the applicability becomes doubtful, by reason of the neighbourhood of a discontinuity, he will assure himself, by a diagram such as those on p. 199, of the limits of the divergence.

These difficulties concerning the discontinuity of functions is very properly relegated to another chapter, number vii., on Functions of Complex Variables, by Thomas S. Fiske, which gives us a very clear account of the most recent manner, of the school of Weierstrass, of approaching such refinements of argument. We are pleased to find the name "one-valued function" instead of "uniform function," which is misleading to the beginner.

Prof. Woolsey Johnson, of the U.S. Naval Academy, contributes Chapter vii., on Differential Equations. His own formal treatise on the subject is well known and highly popular; and the present chapter incorporates the essential, or what Maxwell called the "gentlemanly," knowledge of the subject.

The next two chapters—Chapter viii., on Grassmann's Space Analysis, by Edward W. Hyde, and Chapter ix., on Vector Analysis and Quaternions, by Alexander Macfarlane—seem to us by comparison to be of the nature of luxuries, appealing to the purely analytical spirit; although even here electrical applications are introduced to show how the theories may be usefully applied.

Chapter x. is a short and useful *résumé*, by R. S. Woodward, of the principal parts of Probability and the Method of Least Squares, with which every physical student should now be familiar; and the volume concludes with Chapter xi., on the History of Modern Mathematics, by David Eugene Smith, in which the author is compelled to apologise for the incompleteness imposed upon him by the exigencies of room, but which, nevertheless, provides the most important details required for reference.

The account given by the Editors, in the preface, of the work expected of the average American student, shows that the standard of requirement is much higher than in this country, and not hampered by traditional prejudice.

A. G. GREENHILL.

OSTEOLOGY.

The Vertebrate Skeleton. By Sidney H. Reynolds, M.A. Pp. xvi + 559. (Cambridge: University Press, 1897.)

THIS most recent addition to the Biological Series of the Cambridge Natural Science Manuals edited by Mr. A. E. Shipley, is an attractive-looking volume, well printed, and with the monotony of the text agreeably broken by a judicious use of small capitals, italics, and clarendon type. The numerous illustrations, which are probably accountable for the high price (12*s.* 6*d.*) of the book, though simple in execution are clear in detail, and, on the whole, chosen with discretion. The majority of the figures have not been published before, and are based on specimens contained in the Cambridge University Museum and the Natural History Museum, London. The text is remarkably free from typographical errors, but is frequently bald in style and irritating from

unnecessary iteration. This repetition, it is true, is apologised for in the preface, but it could have been avoided by altering the plan of the book, which as it stands is rather confusing.

What strikes one most on glancing through the pages is the disproportionate treatment of the subject. To devote one-third of the whole book to the mammalian skeleton shows that the author has allowed himself a free hand where the facilities for compilation are greatest—and his indebtedness to the "Osteology of the Mammalia" is admitted in the preface. Where, however, it has been necessary to collect the detailed statements from scattered sources, as, for instance, in Fishes and Amphibia, the results are very far from satisfactory. The parts relating to the Cyclostomi, Ganoid fishes, the shoulder-girdle of Anura, and the hyoid of Reptilia are especially poor. The classificatory scheme (pp. 30-49), including as it does extinct as well as living vertebrates, should prove of considerable service to the student. It is well up to date, and, on the whole, trustworthy, although ichthyologists will probably gird at the inclusion of a physoclistous form like *Exocœtus* among the Clupeidæ. It would have been well if the generic and specific names of the borrowed figures had been checked by reference to some modern catalogue, instead of relying so implicitly upon those used by the original authors. *Galeus*, for instance (Fig. 15), should read *Galeocerdo*, and *Docidophryne gigantea* (Fig. 30), *Bufo marinus*; while the Figs. 16 and 17 of the seven-gilled shark should, in the student's interests, be given the same generic name, either *Notidanus* or *Heptanchus*. The specimen in the Natural History Museum, on which Fig. 16 is based, is marked *Notidanus*, while Gegenbaur's figure, which is reproduced in Fig. 17, is labelled *Heptanchus*, and Mr. Reynolds has, regardless of uniformity, adopted the two names as he found them.

The want of cohesion throughout the text detracts seriously from the value of the book. The various sections, culled from different sources, are not blended together, so that the product is indigestible and difficult of assimilation. The failure to treat the subject from a consistent morphological point of view is, in fact, the great flaw in the book. Positive inaccuracies are not common, but the sternum ought not to come under the head "Hyoid apparatus" (p. 162), the epipubic cartilage of *Xenopus* (p. 188) and the horny beaks of *Siren* (p. 168) are not "minute," and auditory ossicles are not as large as Fig. 100 would lead one to believe. The application of the name "branchiostegal rays" to the endoskeletal cartilages of the branchial septum of selachians (p. 120) implies a false homology with the dermal bones attached to the hyoid arch in bony fishes, while the inclusion of the vomer of the dog (p. 395), under the head "Bones in relation to the Olfactory Capsules," fails to impress upon the student the fact that this bone is morphologically an ossification of the mucous membrane of the roof of the mouth.

That great credit is due to Mr. Reynolds for his conscientious industry and honesty of purpose there is abundant internal evidence to show, but the product of his labours is—a book which is just good enough to suggest how valuable it might have been had its compilation been entrusted to a qualified morphologist. At the same time, Mr. Reynolds is to be congratulated on the large amount of information which he has brought together, and on the fact that he has not neglected the extinct forms. And although, in its present form, the book cannot with advantage be used as a book of reference, while its abrupt and disconnected style renders it ill-adapted for continuous reading, there can be litt doubt that if, when a second edition is called for, the plan of the book were simplified, the inaccuracies corrected, and the various chapters and sections connected up and coordinated, the book would prove a valuable addition to the student's library.

OUR BOOK SHELF.

Studien über Dampfspannkraftmessungen. By Georg W. A. Kahlbaum; with the co-operation of C. G. von Wirkner and others. Part ii. 1st half. Pp. x + 221. (Basel: Benno Schwabe, 1897.)

IN the first part of this work (NATURE, March 8, 1894, p. 436), measurements of the vapour pressures of a number of substances were given. The method used in the determinations was also fully described, and its accuracy discussed. The author's intention was to devote the second part of the book to a discussion of the theoretical bearing of the experimental material collected: Further experiments with substances belonging to chemical groups other than those previously examined revealed, however, the necessity of first enlarging this experimental material; the present volume contains the results of these additional measurements. The experimental method employed is the same as before, and the results are given in the form of numerical tables and of curves. Every precaution appears to have been taken to secure accuracy. Where previous observations exist, the results are compared together, and the satisfactory agreement found between the results obtained by Ramsay and Young, for example, by the statical, and by the authors by the dynamical method, may be regarded as further evidence of the trustworthiness of the latter. In this volume the measurements extend from about 0 to 760 mm., except in cases where the solidification of the substance prevented the measurements at lower pressures. The substances for which new experimental results are given are benzene, brom-benzene, benzaldehyde, phenol, aniline, benzonitrile, benzyl alcohol, nitrobenzene, benzoic acid, ethyl alcohol, propionic, normal butyric, valeric, heptylic, isobutyric and isocaproic acids, methyl-, dimethyl-, ethyl- and diethyl-aniline, phenylmethyl ketone, methyl benzoate and benzoyl chloride.

In connection with the fatty acids, the accuracy of Dühring's rule is discussed. The rule states that the difference between the boiling-points of a liquid at some standard pressure and at any other pressure divided by the corresponding difference for some other liquid is a constant quantity for that pair of liquids. This, it appears, is sufficiently accurate only when the liquids belong to a group of closely related substances, such as the fatty acids.

In conclusion, it is hardly necessary to point out the great value, scientific and practical, of careful determinations, such as those before us, of the vapour pressures of liquids.

The Induction Coil in Practical Work, including Röntgen Rays. By Lewis Wright. Pp. vi + 172. (London: Macmillan and Co., Ltd., 1897.)

THE discovery of the Röntgen rays has created a revived interest in many of the beautiful experiments that can be performed with the aid of the Ruhmkorff induction coil, and is thus indirectly a sufficient justification for the appearance of this treatise of 172 pages. More especially

written for those who, without much previous acquaintance with electrical apparatus, are for purposes of practical utility or scientific recreation anxious for theoretical and practical knowledge on the subject, this little book is also replete with useful information and suggestive hints that will not fail to prove of service to more experienced electricians. The volume is methodically arranged and well illustrated; and if there are omissions which might with advantage have been supplied, these are no doubt largely due to the author having been confined to a limited amount of space. So many experiments connected with the electrical discharge in rarefied and dense gases can be performed not only with an induction coil, but equally efficiently with a Wimshurst or other form of electrostatic influence machine, that one cannot but regret that the author has so rigidly confined himself to the application of coils alone. For a similar reason, it seems a pity not to have included some detailed information as to the so-called high frequency coils of Tesla and Elihu Thomson, which, even as an adjunct to induction coils, are not quite so completely abandoned for X-ray work as the author appears to imagine, while they afford a means for many other instructive experiments of comparative novelty and great beauty. It is necessary to say, moreover, that the brief references that do appear in the book to such coils, as also to the use of alternating currents generally, are scarcely as accurate and as lucid as might be desired.

It is to be regretted that the author uses the word *current* in a loose and, sometimes, in a very misleading manner. Notwithstanding these defects, which it is to be hoped the author may be able to remedy in subsequent editions, the book is undoubtedly the best popular and practical work that has yet appeared on the subject of which it treats.

The Calculus for Engineers and Physicists. By Prof. Robert H. Smith. Pp. xi + 176. (London: Charles Griffin and Co., Ltd., 1897.)

NOT only is "Integration more useful than Differentiation," the author's opening statement, but the conception of Integration is more tangible and easy to grasp than that of Differentiation, a far more abstract idea.

We recognise the growth of a tree after a few years, although the actual rate of growth is infinitesimal.

For purposes of application, a knowledge of Differentiation must just precede the inverse operation of Integration; but that does not justify our present system of carrying the student through the Differential Calculus before starting on the Integral; the two subjects should be carried out, as far as possible, *pari passu*.

Classified Reference Tables of Integrals form a feature of this work; and the author has also touched upon the useful portions of Differential Equations.

Any analytical difficulty is explained preferably by means of a careful diagram (as might be expected from an author of Graphical Calculus), and by intuitive reasoning, rather than by processions of unconvincing equations and inequalties, employed by schoolmen of the pure orthodox mathematical faith; whose indulgence the author begs in his Preface, asking them to remember that there is arising a rapidly increasing army of men eagerly engaged in the development of physical research, . . . whose mental facilities have been wholly trained by continuous contact with the hard facts of sentient experience, and who find great difficulty in giving faith to any doctrine which lays its basis outside the limits of their experiential knowledge. G.

Zur Zoogeographie der landbewohnenden Wirbellosen. Von Dr. Otto Stoll. Pp. 113. (Berlin: Friedländer, 1897.)

THE majority of treatises upon geographical distribution have used as facts and framed their conclusions upon the range of vertebrated animals only. A few manuals, such as M. Trouessart's excellent book, and Mr. Beddard's "Text-book of Zoogeography" in the Cambridge series of scientific handbooks, have attempted a rather wider survey of the facts of the science, the necessity for which is emphasised by the short essay now before us. The main object of the science of geographical distribution is clearly, we take it, to state the facts; but it is illogical to avail oneself merely of a selected series of facts. This is particularly evident in view of another aspect of the science; for some of its more important inferences deal with the former changes in the relative position of oceans and continents. Birds and mammals being comparatively modern creations, can throw no light upon more distant changes of this kind; and facts drawn from those groups are by no means sufficient to serve as a basis for the view, now so generally becoming accepted, that there was in earlier times a vaster antarctic continent than the shrunken remnant now existing. Dr. Stoll strongly supports this notion, and it is from invertebrate groups that arguments are to be drawn. He is, moreover, against the theory of polar dispersal, which by its ingenuity, if for no other reason, has commanded much attention. Dr. Stoll clearly shows the importance of a consideration of invertebrates in discussing the inferences of geographical distribution, and we could have wished that his little brochure of only 113 pages had been more expanded.

Transactions of the American Microscopical Society. Edited by the Secretary. Vol. xviii. Pp. 413. (Buffalo, N.Y.: A. T. Brown, 1896.)

THIS report of the proceedings of the American Microscopical Society at the nineteenth annual meeting, held at Pittsburg in August of last year, is a very creditable publication. Many of the papers are distinctly valuable contributions to science, and the plates which illustrate them are of a high standard of excellence. Among the subjects and authors are the following:—Notes on comparative histology of blood and muscle, by Miss Edith J. Claypole; the character of the epithelium of the peritoneum of the tailed amphibia of the Cayuga lake basin, by Miss I. M. Green; several interesting papers on photomicrography, and on water supply; the red blood corpuscle in legal medicine, by Dr. M. C. White (accompanying this paper are some fine photo-engravings of blood corpuscles of man and various animals, magnified × 10,850, 2560, 840, and 640 diameters); yeasts and their relation to malignant tumours, by Dr. A. R. Defendorf; the bacteriology of diphtheria, by Dr. C. F. Craig; and an instructive address by the President, Dr. A. Clifford Mercer, on the effect of aperture as a factor in microscopic vision.

Experimental-Untersuchungen über Elektricität von Michael Faraday. No. 86, Series iii. to v., pp. 103; No. 87, Series vi. to viii., pp. 179. Edited by A. J. v. Oettingen. (Leipzig: Wilhelm Engelmann, 1897.)

THESE two volumes are the latest additions to Prof. Ostwald's renowned "Klassiker der exakten Wissenschaften"—a series of edited translations and reprints which has no rival. They contain translations of papers read by Faraday before the Royal Society in 1833–4, upon his electrical researches, the translations being from the *Philosophical Transactions* of those years. A few explanatory notes are added by the editor, Dr. A. J. v Oettingen.

Complaints are often made of the neglect of foreign scientific literature by German investigators, but it should be remembered at the same time that we have no series of translations of scientific classics to compare with the one in which the two present volumes appear.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Fullerian Professorship of Physiology at the Royal Institution.

I AM writing in the assurance that my letter will or will not appear in your columns, according as you shall have judged whether or no it deals with public matter. And this again depends upon the degree in which the Royal Institution of Great Britain is regarded as fulfilling a public function.

Briefly, the facts are these:—

I hold the "Fullerian Professorship of Physiology and Comparative Anatomy" at the Royal Institution. I am surprised and disappointed to find that the duties of that post are regarded in a very flimsy light, and that no provision can be made, either in the Institution itself or in the adjoining Davy-Faraday Laboratory towards their more adequate performance. The obvious fact that the lecture-room rests upon the laboratory, acted upon with such admirable effect in the case of physics and chemistry, is altogether ignored in the case of physiology, with the result that the instruction that can be offered to the public in this latter subject is deficient or inferior, and—in the bad sense of these words—popular and literary. The very excellence of the lecture-theatre, together with the absence of any work-room, diverts the activity of the chair into other than its proper channels.

The Royal Institution of Great Britain, although it arose by private enterprise, has now for many years occupied the place of a public organ of natural knowledge, and its title expresses its *de facto* relation to the educated public, who look to the Royal Institution for the best information that can be given in the various subjects there dealt with.

It is a matter for regret—indeed in the present state of ignorance of physiology, which by many otherwise well-informed persons is supposed to be synonymous with vivisection—it is an actual misfortune, that the Fullerian Professors of Physiology are not enabled to give to the Institution the best work of which they may be capable. To profess "physiology" of an inferior character, under the auspices of the Royal Institution of Great Britain, is misleading and injurious to the interests of science.

I have felt some hesitation before requesting you to publish this letter, but can see no other means of testing the correctness of my opinion as to what is due to the public at the Royal Institution of Great Britain by the channel of its Fullerian Professorship of Physiology. AUGUSTUS D. WALLER.

July 5.

Streaming Movements of the Protoplasm in Pollen of Flowers.

IT may, perhaps, not be generally known that pollen of flowers affords a convenient example of the circulation of protoplasm. If pollen from a fox-glove be placed in a solution of sugar at ordinary temperature in a drop-slide, the grains sprout within twenty minutes, and grow during several hours at an average rate of 1/10 millimetre per hour. The granules of protoplasm move in opposite streams side by side, turning at the lower end of the tube and inside the grain; the rate of motion may be calculated at 1 millimetre in one and a half to two minutes. The rapidity and duration of the streaming movement vary in different species; in the pollen of the fox-glove it seldom continues longer than five or six hours, but in that of the bee orchis it may be still observed on the third day, after the tubes have ceased to grow. Protoplasm which has been set free by the bursting of tubes or grains, continues to show signs of life for a longer period. The granular character of the protoplasm is less distinct in some species than in others, but with a sufficiently high power—1/8—a visible motion of the contents of pollen tubes appears to be common. H. B. POTTER.

July 13.

Sensitiveness of the Retina to X-Rays.

WHILE trying a few days ago to detect the position of a coin which a child had swallowed, I found that the retina is affected by the X-rays. I have since learnt that this observation is not new, but my method of work may be of interest. For the purpose of the coin experiment the tube of the usual Jackson type was placed immediately under a table of 1-inch deal in a dark room; on bringing my eye close to that part of the table where a phosphorescent screen showed the most intense radiation, after I had been in the dark for at least ten minutes, I could perceive a faint illumination of the retina, and on moving small metal objects to and fro immediately in front of the eye, I could see their shadows on the retina appearing to move always in the opposite direction. On moving the eye further away from the object the shadow enlarged. It is possible to make out the shape of small letters about ½-inch long cut out in the middle of a sheet of lead, if they are placed close to the eye. It makes very little difference whether the eyelid is open or shut. The front of the eyeball in my experiment was about 4 inches from the platinum radiating plate.

The condition for success is that the observer should be in the dark for some time—not less than ten minutes, and in some cases twenty minutes. A person who has recently been in full daylight appears to require a longer time in the dark before the sensitive condition is developed.

Mason College, July 1. GUY OLIVER HARRISON.

Distant Stars.

IN the interesting extract of Prof. Newcomb's address at the Flower Observatory, University of Pennsylvania, given in NATURE, p. 139, on the distance of the stars, he says:—

"Evidence is gradually accumulating which points to the probability that the successive orders of smaller and smaller stars, which our continually increasing telescopic power brings into view, are not situated at greater and greater distances, but that we actually see the boundary of the universe," &c.

It would be extremely interesting if some of the reasons for this theory were given; it seems so startling to imagine that after all we are practically the "hub of the universe," or very nearly so; and so opposed to the idea that what our most powerful telescopes can show, may possibly only be in proportion to the whole universe as one drop of water to the Atlantic Ocean.

ALBERT COLLISON.

Sound of Distant Firing.

I SEE a correspondent reports hearing the saluting at the Portsmouth Naval Review at Chelsea. It was distinctly audible here, loud enough to be heard at some distance further, though the wind was E.S.E., a fresh breeze, and therefore unfavourable for helping sound. Also there were no clouds—in sight, anyhow—which might aid in reflecting the sound-waves. The reports began a few minutes after 2 p.m., and continued at intervals up to nearly three o'clock, at which time I ceased listening for them. I make the air-line distance just sixty statute miles.

I may add that, when walking on Wimbledon Common, I frequently hear loud detonation, which I put down to Shoeburyness, as I do not know of any other place in that direction at which heavy firing takes place. The distance would be about fifty miles, but across London, which one would think might interfere with sound-transmission. C. MOSTYN.

Wimbledon, July 12.

Blackbird's Nest appropriated by a Wagtail.

THE double bird's nest I send you was found some time ago in a stack of hop-poles when they were taken down for use. The lower nest is clearly a blackbird's, and in it, below the lining, were two blackbird's eggs when found. The upper nest (or lining?) is, I am informed, that of a pied-wagtail, with four eggs, and also the egg of a cuckoo. It is suggested the blackbird was disturbed (by a cuckoo?), and a wagtail, assuming the nest, completed it in its own fashion, the cuckoo therein laying its egg. (The same cuckoo which had disturbed the blackbird?)

The double nest was found by Mr. Pattenden, a farmer here, and seen by his wife and son *in situ*. I have sent you a letter written by the son, and stating how the nest was found. I do not doubt the story is true. F. C. CONSTABLE.

Burwash, Sussex, July 7.

THE ETIOLOGY OF YELLOW FEVER.

YELLOW fever is an acute infectious disease, endemic in the West Indies, the shores of the Mexican Gulf, and in some parts on the West Coast of Africa, whence the disease has been repeatedly transported into other localities, causing here epidemic outbreaks. Like other infectious diseases, yellow fever is supposed to be caused by a specific living entity which, invading a predisposed person, multiplies there and causes the peculiar pathological changes in the gastro-intestinal tract and the liver, characterising yellow fever. Within recent years the supposed specific microbe has been discovered several times. Dr. Domingos Freire, of Brazil, and Dr. Carmona y Valle, of Mexico, have announced such discovery, but Dr. Sternberg, of Washington, who has himself studied the disease on behalf of the United States Government, has shown that none of these discoveries are a reality, and after a prolonged investigation, including the examination of a great many cases affected with, or dead from the disease, has arrived at the following conclusions, embodied in a lengthy report to his Government: that none of the different species of bacilli and cocci, present in the intestinal canal, in the blood, the liver and other tissues of persons affected with yellow fever, can have a claim to be considered as the specific microbe; that in a number of cases the examination, microscopic and cultural, of the blood and tissues yielded no bacteria recognisable either by the known methods of staining or culture; and he finally implied that the specific microbe of yellow fever is most probably not of the nature of a bacterium at all. After these very definite conclusions by Dr. Sternberg, it came rather as a surprise when, some months ago, the announcement was made that Dr. Sanarelli, Professor of Experimental Hygiene in Montevideo, formerly in the Pasteur Institute in Paris, had discovered the true cause of yellow fever in the form of a bacillus, *Bacillus icteroides*. This surprise is still further heightened by the statement in Dr. Sanarelli's lecture, that the *Bacillus icteroides* is demonstrable by the ordinary methods of staining and by culture in the ordinary well-known media. The morphological and cultural characters of the bacillus show it to belong to the group of coli-like bacilli; it is rarely demonstrable in a pure state in the blood or tissues, being generally associated with a more or less copious admixture of other microbes—*Bacillus coli communis*, *streptococci* and *staphylococci*; as a rule it is present only in small numbers in the capillary blood-vessels of the liver, spleen and kidney. It reflects great credit on the perseverance and sagacity of Dr. Sanarelli to have been able, notwithstanding all these difficulties, to select out the *Bacillus icteroides*, and to have by animal experiment been able to demonstrate, at least, as highly probable that the *Bacillus icteroides* is the true microbe of yellow fever. As mentioned just now, the distribution of the microbe in the affected person, its morphological and cultural characters do not in themselves offer strong *prima facie* evidence, and Dr. Sanarelli himself fully recognises this; but when we come to the experimental evidence which he furnishes, the evidence as to the *Bacillus icteroides* being the specific cause of yellow fever assumes considerable power.

In the first place, Sanarelli shows that dogs, goats, and horses are susceptible to infection both with the living bacilli as also and particularly with the highly poisonous toxin produced by the bacilli in broth culture; the symptoms and anatomical lesions hereby produced in these animals in the intestinal tract, the liver and the kidney, bear a striking resemblance to those of yellow fever in man. In the second place, Sanarelli furnishes proof that the toxin produced in broth culture—and separated from the bacillary growth by filtration through a Chamberland filter—when injected into healthy persons causes a prompt reaction in the form of severe disturbance, primarily of the intestinal tract, but also, further, of the general system closely resembling that in yellow fever. It is to be hoped, nay, it may be assumed as certain, that in continuing his investigations Dr. Sanarelli will ascertain the action of the blood of human beings, who have passed through, and recovered from the disease, on the *Bacillus icteroides*. This disease, as is well known, very rarely occurs twice in the same person, and it is therefore highly probable that, as is the case in other similar infectious diseases, the blood after a single attack possesses agglutinating action (*in vitro*), or germicidal action (*in corpore*), or both on the culture of the specific microbe. If on further investigation the blood serum, after an attack of yellow fever, should be found to show such positive actions on the *Bacillus icteroides*, a strong support will thereby be furnished as to this bacillus being the specific microbe. It will be the crowning of prolonged and laborious studies, if Sanarelli by experiments on immunisation of animals—the horse being evidently well fitted for such immunisation—did, as is highly probable that he will, obtain antitoxic serum by which yellow fever can be successfully combated both prophylactically and therapeutically.

E. KLEIN.

THE VARIABLE STAR η AQUILÆ.[1]

THIS essay contains a full discussion of all the available observations of a remarkable variable star, the fluctuation of whose light presents many features the explanation of which is still beset with much difficulty. Of the 12,000 recorded comparisons of the relative brightness of η Aquilæ and neighbouring stars, no less than 7147 are due to the indefatigable perseverance of Julius Schmidt, who for the last twenty years of his life (1859–1879) was director of the observatory at Athens. Taking advantage of the preponderance of Schmidt's records over those of all other observers, the author first investigated the variations of the star's light as shown by these alone, and then examined in how far the results thus obtained were confirmed by the labours of other observers. The discussion of Schmidt's observations was complicated by the circumstance that in the majority of cases he only used two comparison stars, β and ι Aquilæ, one of which there was great reason to believe was itself variable. From the 1700 occasions on which both stars were used, Dr. Lockyer found ι to vary 1·7 grades of Schmidt's scale with a period of about thirty-five years. Associated with this long-period change, the relative brightness of ι was shown to be subject to an annual variability of about one grade, which is clearly traced to the influence of the hour angle at which the stars were compared. This apparent annual variation is, therefore, identical with the "position error" noted by many observers of variable stars, and which has lately been investigated so thoroughly by Mr. Roberts, of Lovedale, South Africa. Schmidt's observations, freed from both the above variations as well as from the slight aberration error due to the changing position of the earth in its orbit, were all reduced to the meridian of Bonn. Owing to the general sparseness of the data, it was necessary to combine the observations of 100 periods, or about two years, into a group represented by a single curve. This was effected with the help of a provisional mean period and date of minimum for which Argelander's values of 7d. 4·234444h. and 1848, May 18d. 6·4333h. M.T. at Bonn were adopted, the date being that of epoch 400. To further facilitate the construction of the curve the mean

[1] "Resultate aus den Beobachtungen des Veränderlichen Sternes η Aquilæ." Inaugural Dissertation zur Erlangung der Doctorwürde, von William J. S. Lockyer. 5 plates, quarto, pp. 95. (Göttingen: 1897. London: Dulau and Co.)

brightness in each 6-hour interval of the period was set down for each group, together with the corresponding time and the number of observations. In this way the whole of the materials collected by Schmidt from 1844 to 1879, and thus covering eighteen groups of 100 periods each, are expressed in tabular form on p. 21 of Dr. Lockyer's dissertation. The numbers for each period were then plotted on millimetre paper; tentative and afterwards definite curves representing the fluctuations of the star's light were drawn through the points thus obtained. The resulting eighteen curves representing Schmidt's observations are reproduced one above the other on a small but distinct scale on Plate I., each curve being prolonged by about one-third of the period to bring out the form of the minimum. A study of these curves shows that Argelander's period cannot, at present, be improved on as a mean value. The *time* of Argelander's epoch 400 is, however, shown to be too early by an interval which the author fixes at 3·2655 hours. The curves also show conclusively that the epoch of maximum oscillates to and fro to the extent of five hours on either side with a period comprising 400 maxima. In the same way the minima are subject to an oscillation of about three hours in approximately 2400 periods. The combined effect of these variations causes the light-period to vary between 7d. 4h. 14m. 40s. and 7d. 4h. 13m. 28s. also in 2400 periods. Superposed on the main light curve are four subordinate undulations, of which more hereafter.

Much the same method was followed with regard to the observations of Argelander, Schönfeld, Heis, Plassmann, Oudemans, Pannekock, Auwers, Knopf, Sawyer and Schur; but with the further step of reducing the estimated grades to Argelander's scale. This reduction, carried out with scrupulous care by the method of least squares, brings out several interesting facts regarding the values which the grade, or unit of brightness, assumes in the case of the different observers, or for the same observer at different times. Here there is only space to mention the observations made by Knopf in Jena. Contrary to the general usage of comparing a variable with stars differing from it in brightness by at most five or six grades, Dr. Knopf often allowed himself a range of no less than nineteen grades. This new departure has most unexpectedly had no injurious effect on the accuracy of the observations, as is abundantly proved by the smallness of the residuals in the evaluation of the brightness of the comparison stars. From the materials collected by the observers just named, the author constructed nineteen further curves, which confirm in a high degree the results from Schmidt's observations alone. Dr. Lockyer also tests the accuracy of his conclusions by means of the long series of observations made by Wurm in the course of twenty-seven years, beginning with 1785. The detail, indeed, of these observations seems never to have been published, but the actual length of the period in accordance with Schmidt, for the epoch of Wurm's observations, differs but seven seconds from Wurm's value; and since the early observations also show decided indications of the oscillation of the time of maximum, it seems certain that the general character of the variability of η Aquilæ has not materially changed in the course of the last hundred years.

As regards the four secondary fluctuations, they are found to recur at intervals of forty-three hours, or one quarter of the main period, the first of these secondary maxima occurring fifteen hours after the chief minimum. The author is the first to have clearly brought out this feature, and he explains it by assuming, in accordance with his father's hypothesis, that the system of η Aquilæ consists of three meteoric swarms, of which the two lesser revolve about the greater in periods of 1d. 19h.+ and 7d. 4h.+ respectively (see "Meteoritic Hypothesis," *passim*, but particularly pp. 475–6). The irregularities in these fluctuations are set down to the perturbations necessarily occurring in such a system, but their investigation did not come within the scope of the essay before us. Figs. 1 and 2 of the dissertation show the proportions of the assumed orbits, together with the form of the light curve resulting from the combination of the two elementary curves. In conclusion, I must express my admiration of the skill and untiring perseverance which Dr. Lockyer has shown in dealing with a large mass of somewhat intractable material. Wherever possible the deductions were made from the original manuscripts, concerning which interesting particulars are given on pp. 19 and 20, where we learn that Schmidt's original notes are preserved at Potsdam, while those of Heis have wandered across the Atlantic to the observatory of Georgetown College.

R. Copeland.

BRITISH ASSOCIATION TORONTO MEETING.

III. Local Arrangements.

The two leading Hydraulic Companies of Niagara Falls are making special arrangements for the reception of the members of the British Association.

The Carborundum Company of Niagara Falls has extended an invitation to the members of the Association to visit and inspect the Company's works on Saturday, August 21. The manufacture of carborundum by this Company has been fully described in Nature for May 13 (p. 42).

The Atlantic Cable Companies have generously arranged that members from Great Britain may send two free cable messages from Toronto, and they will then be entitled to two free replies. Each message and reply are not to contain more than ten words each, and they are to be forwarded by agents recognised by the Cable Companies. The agents in Great Britain will, in all probability, be Messrs. Cook and Son, and in Toronto the Honorary Local Secretaries; but the arrangements in regard to this are not complete, and a fuller announcement will be made later. It is to be noted that the transmission of the messages within Great Britain to and from the head office of Cook and Son will be charged for as ordinary telegraphic messages. The arrangements in this respect are the same as those made in 1884.

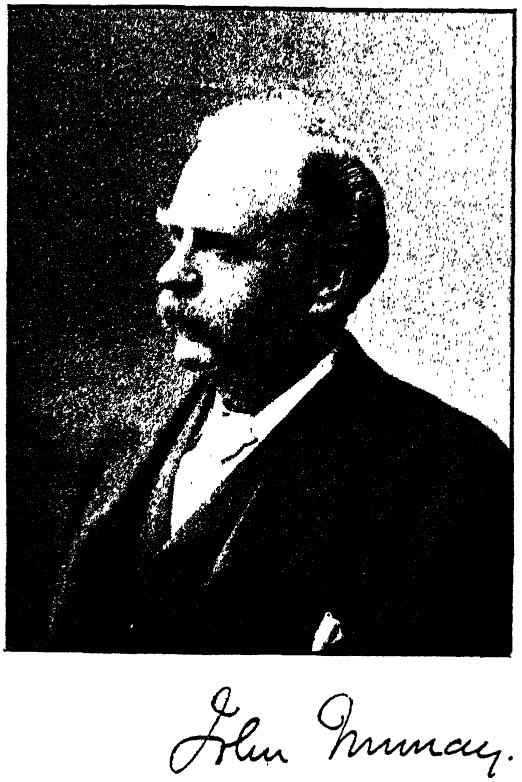
In order to avoid delay in the Customs examination of the members' luggage, the Hon. Mr. Paterson, the Minister of Customs, has given special instructions to the Customs officers at Quebec, Montreal and Niagara to facilitate in every way the examination. A larger number of examining officers will be on duty at Quebec, and one will accompany each steamer from Quebec to Montreal to make the examination of the luggage during the passage. As a result of this arrangement, all delay at Quebec and Montreal will be avoided. The Minister of Customs has also arranged that all scientific apparatus or material for use during the meeting of the Association shall be admitted free of duty if forwarded to me at Toronto, and marked, "For British Association."

It is expected that there will be in attendance at Toronto more than twenty continental men of science of a representative character. Amongst those who have intimated their intention to be present are Prof. Charles Richet, Prof. Yves Delage, both of Paris; Prof. Meslans, University of Nancy; Prof. Gilson, of Louvain; Dr. van Rijckevorsel, of Amsterdam; Dr. Pauli, of Frankfort; Prof. Ladenburg, of Breslau; Prof. Runge, of Hanover; Prof. Brauner, of Prag; Prof. Penck, of Vienna; M. Letourneau, of Paris; M. Gobert, of Brussels; and Prof. P. Magnus, of Berlin.

A. B. Macallum.

THE "CHALLENGER" ALBUM.

AT the Ipswich meeting of the British Association, a couple of years ago, a movement was started amongst the zoologists present to congratulate Dr. John Murray, and offer him some memorial of their appreciation of his services to science, on the completion of his editorial work in connection with the fifty volumes of the *Challenger* Reports. A Committee was formed, with Mr. W. E. Hoyle as Secretary, and the offering eventually took the appropriate form of a handsome album containing the portraits and signatures of the contributors to the *Challenger* Series, with an artistic cover and illustrated dedication designed by Mr. Walter Crane. The presentation was made to Dr. Murray at a meeting held in London on November 30, and the happy thought then occurred to Mr. Hoyle to have the volume, cover, dedication and photographs reproduced, so that all contributors, and some others, might have, if they desired, a



copy of this interesting memorial of the completion of the *Challenger* work. The result is now before us in the form of a thin quarto volume, bound in dark green cloth like the *Challenger* Series, and containing some twenty sheets of portraits, along with reproductions of all Mr. Crane's quaint drawings, and an explanatory introduction drawn up by Mr. Hoyle. Messrs. Dulau and Co. have issued an edition of two hundred copies at 12*s*. 6*d*. each. Most of these are being secured by the contributors, but some copies can be obtained by libraries and individuals who desire to add this supplemental volume to their *Challenger* Series. Some of the original photographs were very good, others were poor, and naturally some of the reproductions are better than others; but all the portraits must be of considerable interest to those who possess, and to those who read the *Challenger* monographs. The volume is similar in size and style to the well-known Reports, and containing as it does portraits of all the eighty-eight contributors to the *Challenger* work, the pity is that there are not enough copies to go round all the libraries that contain the *Challenger* Series. We are enabled to show here the portrait of Dr. Murray himself.

NOTES.

THE Sydney expedition to Funafuti, to make borings in the coral, projected and led by Prof. David, started on June 2, going by steamer to Fiji, and thence by sailing vessel to Funafuti. This expedition has been made possible by the liberality of the Mining Department of the Government of New South Wales, which has supplied all the boring plant free of cost, and by the munificent gift from Miss Walker, of Sydney, of 500*l*., and from the Hon. Ralph Abercrombie of 100*l*. towards the expenses of the expedition.

PROF. SOUILLARD, of Lille, has been elected a corresponding member of the Paris Academy of Sciences.

THE following are the names of the presidents of the several sections of the Australasian Association, the next session of which will be opened on January 6, 1898, under the presidency of Prof. Liversidge, the president-elect:—Section A—Astronomy, Mathematics and Physics, R. L. J. Ellery. Section B—Chemistry, T. C. Cloud. Section C—Geology and Mineralogy, Captain F. W. Hutton. Section D—Biology, Prof. T. J. Parker. Section E—Geography (president to be appointed). Section F—Ethnology and Anthropology, A. W. Howitt. Section G—Economic Science and Agriculture, R. M. Johnson. Section H—Engineering and Architecture, H. C. Stanley. Section I—Sanitary Science and Hygiene, Hon. Allan Campbell. Section J—Mental Science and Education, John Shirley.

THE third annual meeting of the Botanical Society of America will be held in Toronto on August 17 and 18, under the presidency of Dr. J. M. Coulter. The address of the retiring President, Dr. C. E. Bessey, will be given on the evening of the opening day.

THE summer meeting of the Institution of Mechanical Engineers will open at Birmingham on Tuesday, July 27. On the morning of that day there will be a reception by the Lord Mayor in the Examination Hall of the Municipal Technical School. The papers to be read and discussed deal with "Some Points of Cycle Construction," by Mr. F. J. Osmond; "The Birmingham Corporation Waterworks," by Mr. Henry Davey; "High Speed Self-lubricating Steam Engines," by Mr. Alfred Morcom; "Mechanical Features of Electric Traction," by Mr. Philip Dawson; and "Diagram Accounts for Engineering Work," by Mr. John Jameson. A large number of works in Birmingham, Wolverhampton, Oldbury, Tipton, Walsall, and Coventry will be thrown open for the inspection of members. On Wednesday the excursions will be to Wolverhampton district, on Thursday to Stratford-on-Avon and Walsall, and on Friday to Coventry, Warwick, and Rugby.

THE Paris correspondent of the *Times* reports that at the meeting of the Institute of France on July 7, the chief business of the sitting was the consideration of the bequest made to the Institute by the late Duc d'Aumale of his estate of Chantilly, and the discussion as to whether the conservators of the château and grounds should be appointed for life or for three years only. By 58 votes to 53 the Institute decided that the appointment should be for three years, and M. Mézières, of the French Academy, M. Gruyer, of the Academy of Fine Arts, and M. Léopold Delisle, of the Academy of Inscriptions and Belles Lettres, were almost unanimously chosen as conservators for the next three years. The conservators of the new "Condé

Museum" are to receive an annual stipend of 3000f. and to be lodged at Chantilly. The financial administration of the estate will not, however, devolve upon them, but upon three other members of the Institute to be subsequently appointed. Later information has been received saying that M. Limbourg has been appointed Administrator-General of Chantilly.

WE regret to notice the death of Prof. W. Marmé, Director of the Pharmacological Institute of Göttingen; Dr. Giuseppe Fissore, formerly Professor of Pathology in the University of Turin; Dr. E. Legros, Professor of Physiology in the new University of Brussels; and Dr. Maréchal, formerly Professor in the Naval Medical School of Brest. The last-named died of septic poisoning.

MR. R. D. OLDHAM, the Acting Director of the Geological Survey of India, has sent to a correspondent a letter on the recent earthquake in Calcutta, from which we have been permitted to make the following extracts:—"I was at Naini Tal at the time, and as soon as I knew how bad it was, came down here [Calcutta] to make arrangements for a thorough investigation of it. At present it is not possible to say more than that it is the biggest and most severe of which there is any record in India, and that its investigation will be attended by considerable difficulty and inconvenience, not to say hardships, to the men employed, owing to the rainy season having commenced immediately after the earthquake. I have had orders from Government to prepare a full and detailed scientific report in the Geological Survey Department; have issued circulars to all station masters, telegraph officers, and other people likely to be able to give information, and have despatched every available man to investigate the damage done at all accessible places. Some that would have been worth visiting are, unfortunately, inaccessible at this season of the year."

IN addition to the foregoing communication we have received a lengthy letter on the subject, and a photograph, from Mr. T. D. La Touche; and these we hope to publish in a subsequent issue.

A DINNER was held on the 7th inst., under the presidency of the Duke of Cambridge, to commemorate the twenty-first anniversary of the formation of the Sanitary Institute. Speeches were delivered by Lord Kelvin, Sir Douglas Galton, Prof. Corfield, and others.

The American Naturalist notes that Dr. W. H. Evans, of Washington, D.C,, has gone to Alaska for several months to investigate the agricultural resources and possibilities of that portion of the territory lying south of the Aleutian peninsula. He will report to Congress as to the advisability of establishing experiment stations there. Dr. Sheldon Jackson is to collect similar information regarding the Yukon Basin.—Prof. Nelson, the University of Wyoming botanist, will make an excursion into the Red Sea Desert. This tract of land has, so far, never received a botanical investigation, and the Professor has planned to make three other trips into the desert during the summer. He expects to obtain many rare botanical specimens.—Prof. Bruner, of the University of Nebraska, has sailed for Buenos Ayres, where he will spend a year investigating the injurious locusts which have, of late, increased enormously in three of the eastern provinces of the Argentine Republic.

WE learn from the *Journal of Botany* that Mr. George Murray and Mr. V. H. Blackman have sailed for the West Indies, in order to work at the plant-plankton of the Atlantic, especially the forms found remote from coastal waters, such as the coccospheres and rhabdospheres. Their method of capture is by pumping sea-water through very fine silk bags, thus attaining practically the same result as by the tow-net, and without stopping the ship.

ACCORDING to *Science*, Major Powell is at present on the coast of Maine, engaged in research concerning shell mounds, in the interest of the Bureau of American Ethnology.

A MEETING was recently held in Glasgow, on the initiative of the Lord Provost, the Principal of the University, and the President of the Faculty of Physicians and Surgeons, to further the proposal to establish a memorial to William and John Hunter, and an executive committee was appointed to collect subscriptions; it is hoped that from 3000*l*. to 4000*l* may be raised.

THE Berlin Town Council, on the motion of Prof. Virchow, has decided to appoint a municipal "hydrologist," for the constant examination and hygienic supervision of the different Berlin waterworks. In connection with this appointment, the creation of a municipal board of health for the city of Berlin is being much discussed. If such were established, the municipal hospitals, orphanages, and asylums would be placed under its control, and also the municipal schools.

THE Park Board of New York City has adopted the plans for the buildings of the new Botanical Gardens in Bronx Park, as modified by the directors in accordance with the advice of the committee appointed to consider the question.

THE German *Imperial Gazette* of a recent date contains the regulations issued by the Government for the sale of Prof. Koch's new tuberculin, under which name the new specific will be sold by chemists in phials containing one millilitre at marks 8.50, and in phials containing five millilitres at marks 42.50. The tuberculin will only be given to certificated medical men, or to those provided with an authorisation from such.

THE July part of the *Journal of Anatomy and Physiology* announces that in consequence of the death of Sir George Murray Humphry, it has been considered advisable to reorganise the editorial staff. With the October part the *Journal* will, as regards anatomy, be conducted by Profs. Sir W. Turner, MacAlister, Cunningham and Thane; and the physiological department will, as heretofore, be in the hands of Prof. M'Kendrick.

IN our issue for June 24 we briefly described the run of the *Turbinia* from the Tyne to the Solent. We understand that during the three weeks the *Turbinia* was in the Solent she made frequent runs of many miles at a time, at speeds of from 30 to 35 knots, and that her performances were witnessed by many leading authorities in naval matters, as well as the mercantile marine. On Tuesday, June 29, with a distinguished company on board, she was run up to nearly full power, and maintained the unprecedented speed of 35 knots, or over 40 miles per hour, for the length of the line of battle-ships, or about 5 miles. During this run there was an absence of strain, and from this fact it seems that the limit of speed in this little vessel has not yet been reached, and that after further improvements, at present in progress (having returned to the Tyne last week), she will be capable of not only maintaining her position as much the fastest vessel afloat, but will be able to give many knots to any competitor engined with reciprocating engines. We purpose, in a subsequent issue, to give a further account of the compound turbine engines which, by the most direct and economical conversion of the power of the steam into effective horse-power in engines of unprecedently small weight, enable the *Turbinia* to achieve without stress or vibration such remarkable results.

THE Pilot Chart of the North Atlantic Ocean for July, issued by the American Hydrographic Office, contains a supplementary chart showing the tracks of floating bottles which have been returned to that office during a year ending June 1 last. Of

the bottles recovered, eighty-one were thrown overboard in the North Atlantic, and these are the only ones dealt with upon the chart in question. Taken collectively, the courses followed by the bottles elucidate the main principles of oceanic circulation, and show the close agreement that exists between the motion of the surface water and the direction of the prevailing winds. Dividing the list into groups, according to latitude, and dealing only with those bottles whose drifts exceed 300 miles, we have the following average velocities of the daily drift:—North of 50°, 5·3 miles; between 40° and 50°, 5·3 miles; between 20° and 40°, 5 miles; between 0° and 20°, 9·8 miles. A noteworthy drift shown on the chart, is that of a bottle thrown overboard in lat. 2° 9′ S., long. 30° 25′ W., and picked up on the African coast, at the mouth of the Bathurst River. This bottle, set adrift in the strong south equatorial current, must have been transferred to the Guinea current, and carried by it to the exceptionally northern position at which it was recovered.

THE Director of the National Observatory at Athens (M. Eginitis), has made an important contribution to the meteorology of Southern Europe by the publication of a careful discussion of the observations at Athens during the present century, and now continued at the Observatory. Although there are several interruptions in the continuity of the earlier observations, they have been carried on regularly during the last thirty-seven years. The discussion, which extends to 220 large quarto pages, contains an exhaustive account of the climate, each element being separately treated, and, in addition to the instrumental observations, notice is taken of all information obtainable from the most ancient periods. The absolute extremes of temperature vary from 105·3° to 19·6°, giving a range of 85·7°. Rain falls, on an average, during ninety-eight days in the year, the normal annual amount being 16 inches. Athens enjoys a large amount of sunshine, the values recorded by a Campbell instrument in 1894 amounted to 2527 hours; at Eastbourne in the same year the amount registered by a similar instrument was 1669 hours. In some years the sun shines incessantly from morning till evening, for a month at a time.

THAT birds play an important part in relation to agriculture has long been known to ornithologists; but farmers have a tendency to dwell upon the harm they do, rather than the benefits received. A better feeling is, however, being cultivated by means of the publications of the Society for the Protection of Birds, by County Councils, and by a host of books on birds; so that the hope may be cherished that agriculturists will soon be able to discriminate between their feathered friends and foes. In the United States, serviceable knowledge of this character is communicated to all who are concerned with it. For instance, in the *Farmers' Bulletin* (No. 54), which has just been issued by the U.S. Department of Agriculture, Mr. F. E. L. Beal describes "Some Common Birds in their Relation to Agriculture." The *Bulletin* contains short accounts of the results of food studies of about thirty grain and insect eating birds belonging to the different families. It is pointed out that the value of birds in controlling insect pests should be more generally recognised; for while it may be an easy matter to exterminate the birds in an orchard or cornfield, it is an extremely difficult one to control the insect pests. How very valuable birds are, is illustrated by the fact that during the recent plague of Rocky Mountain locusts in the Western States, it was found that locusts were eaten by nearly every bird in the region, and that they formed almost the entire food of a large majority of this species. In winter sparrows are active weed destroyers, weed seed forming an important item of the winter food of many of these birds.

THE uncertainty which attaches to the specific-heat-ratio of gases as a means of distinguishing between monatomic and polyatomic molecules renders it of great interest to investigate other properties dependent on the molecular volume or cross-section. In the *Proceedings* of the American Academy of Arts and Sciences, xxxii. 11, Messrs. A. A. Noyes and H. M. Goodwin describe a new determination of the viscosity of mercury vapour and its comparison with those of hydrogen and carbon dioxide, the method used consisting in measuring the flux through a capillary tube under constant difference of pressure. By the application of O. E. Meyer's formula, the authors deduce that the cross-section of the mercury molecule or of its sphere of action is nearly the same as that of the carbon-dioxide molecule, and about two and a half times as large as that of the hydrogen molecule. Whether the authors are justified in their conclusion, "that atoms and molecules are of the same order of magnitude," depends on how far the value of the ratio of the specific heats in mercury is admitted to be indicative, on the kinetic theory, of the monatomic nature of that gas.

A NOTE has been communicated to the *Atti dei Lincei* by Dr. Emilio Oddone, on an apparatus for determining the thermal conductivity of substances which are bad conductors. The apparatus is based on the model of one constructed and described by Dr. Venske, of Göttingen, in 1891, and the author describes a determination made by it for glass. It is proposed to apply the method to the conductivity of rocks, and we hope that the investigations will throw fresh light on the past history of the earth.

IN a very suggestive, privately published, essay entitled "Demeter und Baubo, Versuch einer Theorie der Entstehung unsres Ackerbaus," E. Hahn puts forward a number of new views, and combats many old ones. He believes that man was primitively an omnivorous "collector," later he severally diverged into a hunter, a fisher or a planter, or in certain districts into a herder; but he denies the evolutionary series of hunter, herder and agriculturist. He argues that the first cultivated plant was millet, and he draws a sharp distinction between hoe-culture and the cultivation of cereals with the use of the plough. He believes barley was the earliest cereal, and wheat the latest. There is no necessary connection between our method of tillage with the plough (with the keeping of domestic animals), and the use of milk. Cattle were first domesticated as draught animals and to draw the plough, and it was only long afterwards that they were trained to yield milk for human food. The author is greatly impressed with the effect of religion on the progress of early culture; for example, he holds that the waggon was originally employed for the transport of effigies of the goddess of fertility, probably the moon, and that later it became a secular vehicle. He does not believe that wheels were evolved from rollers, but that they were derived from spindle-whorls, four of which were attached to a board, and so arose the diminutive and primitive conveyance of the goddess. The author invites criticism, and would be glad of references to researches bearing on his subject; these should be addressed to him, care of Max Schmidt, bookseller, Lübeck.

HERR F. R. FRIIS has just completed and published the correspondence between Tycho Brahe and Oligerus Rosenkrantz during the years 1596 and 1601. This book, which is entitled "Epistolæ quas per annos a 1596 ad 1601 Tycho Brahe et Oligerus Rosenkrantzius inter se dederunt," contains in its 80 pages twenty-four letters, most of which were written by Tycho Brahe *to* Rosenkrantz. In the appendix are given ten other interesting communications, written about the same time. The compiler of this collection is to be congratulated on the important service he is rendering history by this collection, which is a further addition to letters already published. The first publication was entitled "Tychonis Brahei et ad eum doctorum virorum Epistolæ ab anno 1568 ad annum 1587," and

was accompanied "cum effigie Tychonis Brahei et exemplo ipsius manus." We may mention that only a small number has been printed, and those wishing to acquire copies can do so from the following address:—F. R. Friis, Copenhague, Cart Adelersgade 7.

THE report on the operations of the Department of Land Records and Agriculture, Madras Presidency, for the official year 1895-96, has just reached us, and is full of interest. The department, during the period under survey, appears to have been most active in the performance of its duties, and good work was carried on, or attempted under, in many instances, great disadvantages. The unfavourable character of the weather caused a failure in many of the planting experiments. Courses of lectures were delivered on the subjects of agricultural chemistry and veterinary science, and experiments were made with various kinds of ploughs in Kurnool district. Inquiries were made "as to whether any animal or vegetable parasites have been anywhere observed, or can be found feeding upon the prickly-pear in such a manner as to warrant a hope that it might be used as an agency for destroying the said plant," and the opinion arrived at, from the reports received, was that there are no parasites known in the Presidency which can be depended upon to destroy prickly-pear growth.

THE alleged reflexion of kathodic and Röntgen rays have been made the subject of two independent but closely-allied investigations by Prof. A. Battelli (*Nuovo Cimento*, v. 4) and M. P. Villard (*Bull. Société Française de Physique*, 95). Prof. Battelli's conclusions are as follows: (1) It cannot be asserted that kathodic rays are reflected according to the regular law; (2) rays coming from the speculum of a focus-tube have the same properties as direct kathodic rays; (3) the same properties are possessed by rays coming from the anterior face of a very thin lamina, on whose posterior face kathodic rays impinge; (4) a pencil of such rays seems to be constituted of different kinds of rays which, when they fall on a thin body, appear to traverse it in somewhat the same manner that they would traverse a filter which allowed some rays to pass through more freely than others. M. Villard finds that kathodic rays that have fallen on a thin metallic lamina, emerge in the form of a diffused pencil, whose general direction is normal to the lamina, but the phenomenon appears to be a kind of refraction. Reflexion is more easily obtained, and the phenomenon can be photographed; the reflected rays possess all the properties of kathodic rays, and are strongly deflected by the repulsive action of the kathode. Experiments show that this reflexion, though evidently anomalous, is perfectly definite.

DR. ITALO BOSI contributes to the *Nuovo Cimento*, 4, v. a series of observations on the electric resistance of solutions of salts in motion, which have an important bearing on Hittorff's and Arrhenius' theories of electrolysis. Dr. Bosi finds that in solutions where the effect of electrolysis is to produce greater concentration at the positive pole, the resistance increases when the liquid is moving in the opposite direction to the current, and decreases when it is moving in the same direction; but the increase in the first case is greater than the decrease in the second. Where the concentration is greater at the negative pole the effect is reversed; the increase of resistance, however, still exceeds the decrease. Finally, when electrolysis produces no difference of concentration at the two electrodes, the resistance is unaffected by the motion of the liquid. These conclusions do not entirely accord with the hypotheses either of Hittorff or of Arrhenius. An investigation somewhat allied to the present had previously been made by Edlund, but this was rather qualitative than quantitative in character, and, moreover, the fluids used by Edlund (town water, alcohol and water, and others) left some doubt as to the nature of the dissolved salts contained in them.

THE *American Naturalist* for June contains an account, by Mr. G. C. Whipple, of the biological laboratory instituted by the Boston Water Works for the examination of the purity of the water supplied to that city. The object of the laboratory work is to ascertain and keep a record of the condition of the water in all parts of the supply at the same time. The microscopical work consists chiefly in the quantitative determination of the various microscopic organisms, except bacteria, in each sample of water, by the Sedgwick-Rafter method. In addition to this, the number of bacteria is determined in the water of all the reservoirs, aqueducts, and service-pipes, and a careful watch is kept for those of a pathogenous character. It is stated that the work done in this and in other similar biological laboratories in Massachusetts (there is a separate one for the city of Lynn) has been of great value, both from a purely scientific and from a sanitary point of view, and that by these investigations the supply of inferior water has several times been prevented.

IN "Minnesota Botanical Studies" (*Bulletin* No. 9, Parts x. and xi.), published by the Geological and Natural History Survey of Minnesota, are several papers of more than local interest. Mr. J. M. Holzinger calls attention to some mosses found by him at high altitudes. On Pike's Peak, Colorado, between altitudes of 12,502 feet and the top of the peak (14,147 feet), he collected thirty species of mosses which deserve attention. Mr. R. N. Day contributes a paper on the relative value of various forces operative in the production of the positions of dorsiventral leaves. He concludes that light cannot induce epinasty or hyponasty, and adds: "This is in direct support of the position taken by Vines, and the results upon which it is based demonstrate that the photo-epinasty of Detmer does not exist as such." Mr. A. A. Heller gives a valuable description of the ferns and flowering plants of the Hawaiian Islands; and the phenomena of symbiosis is the subject of a paper by Mr. Albert Schneider. Mr. Conway MacMillan, State Botanist of Minnesota, discusses his observations of the distribution of plants along the shores of the Lake of the Woods, the purpose of his paper being to point out the dependence of plant formations over such an area as the shores of the lake upon topographic and environmental conditions. It is shown how each formation may be explained briefly as connected with a certain *mélange* of outward conditions, and an effort is made to analyse these conditions both by themselves and as connected with the growth of vegetation.

THE first part of an "Essai sur les éléments de la mécanique des particules," by M. H. Majlert, has been received from MM. Gauthier-Villars et Fils, Paris. The object of the work is to bring forward some new geometrical views on problems of hydrodynamics. In the present part, entitled "Statique particulaire," the author deals with general principles referring to matter and energy, atoms and molecules, states of aggregation of simple bodies, chemical combinations, and co-related subjects. He reserves for a second part, to be published under the subtitle "Dynamique particulaire," the results of his special studies on energy and its manifestations; and we reserve our review of the work until that part appears.

THE fourth number of *Archives of Skiagraphy*, edited by Mr. Sydney Rowland, has just been published. Among the subjects and objects illustrated upon the six collotype plates are the dislocation of an elbow, fracture of radius and ulna, the lobster, edible crab, hermit crab, and five of Dr. Macintyre's Röntgen photographs of a frog's leg in movement.

SEVERAL articles on subjects of scientific interest appear in the July magazines. Mrs. Percy Frankland gives in *Longman's Magazine* an outline of the rise and development of bacteriology during the past sixty years; and to *Good Words* she contributes a sketch of the career of the great leader of bacteriological

science, Pasteur. The Zoological Gardens at Amsterdam are described in *Macmillan's Magazine* by Mr. C. J. Cornish; and Mr. H. W. Seton-Karr narrates in the *Century* his hunting experiences in Africa and India, referring incidentally to his discovery of palæolithic flint implements in Somaliland. An interesting account of the discovery of the American continent by the Cabots, illustrated from original documents, autograph letters and ancient maps, is contributed to *Scribner's Magazine* by the Marquis of Dufferin.

THE Department of Agriculture, Brisbane, Queensland, has recently issued the second edition of "A Companion for the Queensland Student of Plant Life, and Botany Abridged," by Mr. F. M. Bailey, the Colonial Botanist. Many of the notes are given with a view to assist school teachers, and particularly those residing in the country districts, to some of the more prominent distinctive characteristics of common plants. We notice that copies of the pamphlet can be obtained free by persons interested, on application to the Under-Secretary for Agriculture, Brisbane.—A translation, by C. S. Fox, of the official "Guide to the Royal Collections of Dresden," comes to us from Albanus, of Dresden. In it will be found very full information as to the collections housed in the Museum (Zwinger), the Royal Palace, the Johanneum Museum, the Albertinum, and the Japanese Palace. It remains to be said that the Guide is very well got up.—The third report of the Commissioners of the Whitechapel Public Library and Museum has reached us, and contains much interesting matter. Science is not overlooked in Whitechapel, as the list of sixteen lectures by well-known men of science shows. The library contains, in its lending branch, 541 books dealing with natural science, and in works relating to voyages and travels 614 books. In the reference department natural science is represented by 444 works, and voyages and travels by 89. We are sorry to see that there was a falling-off in the number of readers of books dealing with the subjects mentioned, as compared with the numbers given in the preceding report.

AMONG official American publications relating to botanical and agricultural science recently received, are the following:—Twentieth Annual Report of the Connecticut Agricultural Experiment Station for 1896, chiefly devoted to the properties and analysis of fertilising manures; Studies on American Grasses, being Bulletin No. 8 of the U.S. Department of Agriculture, Division of Agrostology (New or little-known Grasses, by F. Lawson-Scribner; Leaf-structure of *Jouvea* and of *Eragrostis obtusiflora*, by Miss E. L. Ogden); Bulletins Nos. 141–144 of the Michigan State Agricultural College Experiment Station (Forage crops and Wheat; Small fruit trials at the College; Fruit tests at South Haven; Vegetables, old and new).

THE additions to the Zoological Society's Gardens during the past week include a Syrian Bear (*Ursus syriacus*, ♀) from the hills north of Bagdad, presented by Mr. B. T. Ffinch; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. B. Gowing; an Osprey (*Pandion haliætus*) from Aberdeenshire, presented by Major-General Russell, M.P.; a Cayman-Island Amazon (*Chrysotis caymanensis*) from the Cayman Islands, presented by Mr. C. Home Sinclair; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Mrs. Reynell; a Shag (*Phalacrocorax graculus*) British, presented by Mr. Edward Step; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Amy Meyer; a European Tree Frog (*Hyla aborea*) from Southern Europe, presented by Mrs. Nicolas Wood; a Bonnet Monkey (albino) (*Macacus sinicus*, ♂) from India, a Rock-hopper Penguin (*Eudyptes chrysocome*) from the Antipodes Islands, a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from the Stewart Islands, a Graceful Ground Dove (*Geopelia cuneata*), two Ganga Cockatoos (*Callocephalon galeatum*) from Australia, deposited; a Dwarf Finch (*Spermestes nana*) from Madagascar, two Barred-shouldered Doves (*Geopelia humeralis*) from Australia, two Chinese Turtle Doves (*Turtur chinensis*) from India, purchased; an English Wild Bull (*Bos taurus*), two Common Blue-Birds (*Sialia wilsoni*), four White-backed Pigeons (*Columba leuconota*), two Triangular-spotted Pigeons (*Columba guinea*), a Spotted Pigeon (*Columba maculosa*), a Crested Pigeon (*Ocyphaps lophotes*), an Auriculated Dove (*Zenaida auriculata*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

JUPITER'S SATELLITES.—In a previous note we referred to the period of rotation of the third satellite of Jupiter as determined by recent observations made by Mr. Douglass at the Lowell Observatory. In the current number of the *Astronomischen Nachrichten* (No. 3432) he communicates a more detailed description of the observations, together with reproductions of the surface markings, which led him to the determination of the length of the period of rotation. Attempts were at first made to discover signs of surface movement within three to five hours of continuous observation. None, however, could be detected, so that the 24-hour period had to be discarded as untenable. A large series of sketches showed that the satellite's period was nearly the same as its period of revolution, namely, 7d. 5·1h. ± 1·2h. The surface markings seem to take the form of lines, their maximum width being estimated at less than 0″·1, or 200 miles. The fourth satellite was also observed minutely, and on its surface were seen markings which are described as similar to those found on the third. Its period of rotation was also noted as being probably nearly equal to its period of revolution round its primary. Prof. W. H. Pickering's discovery of the variability in the elongation of the first satellite seems to be confirmed by Mr. Douglass, who found this satellite at the time of observation "most remarkably elongated."

THE CONSTANT OF ABERRATION.—Mr. C. L. Doolittle has recently concluded a discussion of several observations with the object of determining the value of the constant of aberration (*Astr. Journal*, No. 406). The series of observations used possessed some special advantages for such an investigation, since the stars were distributed very uniformly throughout the twenty-four hours of right ascension, and each group was observed both morning and evening at approximately the same interval before and after midnight. In all, 107 pairs of stars were used, the series extending from 1892 October 10 to 1893 December 27: these included 1744 determinations before, and 1052 determinations after midnight. The final value obtained, namely,

$$20''\cdot55 \pm 0\cdot01$$

seems rather high when compared with those obtained by other investigators. The following brief table brings together a few of the results previously determined.

					″
1843	...	...	Struve	...	20·445
1844	...	...	C. A. F. Peters	...	20·503
1849	...	...	,,	...	20·481
1850	...	...	Maclear	...	20·53
1861	...	...	Main	...	20·335
1882	...	...	Downing	...	20·378
1883	...	...	Nyrén	...	20·492
1888	...	...	Küstner	...	20·313
1895	...	...	Newcomb	...	20·511

CATALOGUE OF 480 STARS FOR ZONE OBSERVATIONS BETWEEN −20° AND −80°.—Ten years ago Prof. Auwers published a list in the *Monthly Notices* of 480 stars to serve as standards for zone observations. It was then suggested that these stars should be systematically observed at those observatories situated in southern latitudes. Sufficient material has, however, been obtained to enable Prof. Auwers to publish in the current number of the *Astronomischen Nachrichten* (No. 3431–32) a complete catalogue of the positions of these 480 stars, together with a selection of nineteen other southern fundamental stars. Prof. Auwers mentions, however, that we must not treat the

places of all these stars as if they were as accurately determined as fundamental stars should be, because there was not in some cases sufficient material for the determinations of accurate proper motions. It is suggested that after an interval of fifteen to twenty years these stars should be again systematically observed and computed afresh. The catalogue, which is arranged for the epoch 1900, further contains the values of Bessel's constants computed for that year. There is also added the places of twenty-four stars, lying near the south pole, which have been chosen by Dr. Gill, and observed at the Cape Observatory.

LATITUDE OBSERVATIONS AT THE U.S. NAVAL OBSERVATORY, WASHINGTON.—Prof. W. Harkness describes the results of a determination of the latitude, and its observed variation, of the Washington Observatory in the *Astronomical Journal* (No. 404). The method employed involved the use of two instruments, namely, the transit instrument, of 77 inches focal length and 4·86 inches aperture in the prime vertical, and the meridian instrument of 30 inches focal length and 2·55 inches aperture; the latter could be used either as a transit instrument or as a zenith-telescope. The plan of work adopted was to observe α Lyræ at every possible culmination, both night and day, throughout the year, and also to observe four other stars near the times of their maximum aberration, in order to eliminate the latter constant from the latitude variation. The final result of the investigation is given in a table showing the observed values of the variation of the latitude.

APPEARANCE OF D'ARREST'S COMET.—A communication from America informs us that Prof. Holden telegraphs that D'Arrest's comet was observed by Perrine June 28·9764 Greenwich mean time. Apparent R.A. 30° 21′ 9″. Apparent polar distance 83° 46′ 29″. The ephemeris, which was given in *Ast. Nachr.*, No. 3405, requires the correction, according to Prof. Kreuz, of −3m. 58s. in R.A. and −4′·4 in declination.

SPECIES OR SUBSPECIES?

OF late attention has frequently been called in scientific journals to that rapid multiplication of nominal species of mammals which forms one of the most striking features of the systematic zoology of the last few years. To take an extreme instance: In eastern Europe and northern Asia there exists a pretty little rodent allied to the squirrels, and forming the single Old World representative of the genus *Tamias*. Until quite recently this creature was supposed to be common to North America, and was generally known as the Asiatic Chipmunk (*T. asiaticus*); and it is not many years ago that a well-known American zoologist fully recognised the specific identity of the eastern and western forms. Soon afterwards, that very same writer not only separated the American from the Asiatic race, but considered that the former constituted more than a score of distinct species! To take another example. The coyoté, or prairie wolf, has been very generally recognised as constituting a well-marked species distinguished from the ordinary wolf, not only by its inferior size, but by differences of colour and pelage. During the present year Dr. C. H. Merriam, the well-known Government zoologist of the United States, has, however, thought proper to split up the coyoté into a number of what he regards as distinct species. And it may be added that he has done the same for the brown and grizzly bears of his own continent, and also for those of north-eastern Asia.

It is, perhaps, needless to say that this species multiplication is a direct consequence of the increased attention which has been given of late years to the collection and description of mammals; and that, so far as the actual work itself is concerned, we have nothing but praise to bestow on the workers. Every one will admit that we ought to know as much as possible about all animals, and that if an American bear, wolf, or stoat can be distinguished from its cousin of the Old World, it is right and proper that the differences should be duly recorded. But is it right or advisable to bestow distinct specific names on animals so near to one another that it often requires the aid of a specialist to distinguish the one from the other? No one will deny that the lion and the tiger constitute a couple of well-marked species of the genus *Felis*. If, however, we trace the Indian tiger westwards into Persia and northwards into Central Asia, we find that it gradually assumes a longer coat, and either increases or decreases in size. Consequently, some zoologists regard the Siberian (and, for what I know, the Persian) tiger as a species distinct from the royal tiger of Bengal. Apart from the question whether the two intergrade in the intermediate area, if this view be adopted, we have now three species instead of two to deal with, namely the lion, the Bengal tiger, and the Siberian tiger; but it will be obvious that the two last differ from one another much less markedly than they both do from the first. If we only use English names, no very great harm is done, for we still see that two forms are tigers, while the other is a lion. In scientific nomenclature the case is, however, different, for each form receives a distinct specific name under the generic title of *Felis*; and hence there is no means of knowing by the nomenclature alone that two of the three are intimately related, while the other is widely different. Consequently, when we meet with the names *Felis tigris* and, say, *Felis sibirica*, and are told that the former is confined to India, we lose sight of the very important fcat that essentially the same type of animal ranges from Ceylon and India to the arctic tundras of Siberia; the difference in the length and thickness of its fur being obviously adaptations to its different climatic surroundings.

Precisely analogous instances occur in the case of the wolves and bears. The wolf of Europe is closely allied to the large American wolf, and very distinct from the coyoté, but if we separate the European wolf as one species, make several of the large American wolves, and several more of the coyoté, we have no clue to their mutual resemblances or differences; and we thus miss much important information about geographical distribution which ought to be apparent at first sight. Take, again, the deer allied to the red deer. The latter (*Cervus elaphus*) is a very distinct species confined to the Old World. In America it is represented by the wapiti (*C. canadensis*), which differs in colour, voice, and the form of its antlers. But there exists in Central and North-eastern Asia a deer so closely allied to the wapiti, that from the characters of the antlers alone the two cannot be separated. Now, if we regard this deer as a distinct species, under the name of *C. eustephanus*, we have obviously no means of knowing that it is much more nearly related to the wapiti than it is to the red deer, and we also lose sight of the circumstance that whereas the group to which the latter belongs is confined to the eastern hemisphere, the wapiti group is common to the north and north-eastern portions of both hemispheres.

But this is not all. By using specific terms in a wide sense the amateur zoologist and sportsman is able to keep in touch with the working zoologist, and thus to participate largely in the more important discoveries and advances of the science; whereas when specific distinctions are made on the minute differences now in vogue, he is utterly at sea, and probably throws up the whole study. Very likely the pure systematist may say that this is a matter of no moment, although this is not our own view.

What may be called the revolt of the amateur and sporting naturalist against the undue splitting of the modern specialist, has been initiated by Mr. Theodore Roosevelt, in an article in our contemporary *Science* for April 30, under the title of "A Layman's Views on Specific Nomenclature." Mr. Roosevelt, who holds the important office of President of the Board of Police Commissioners of New York, modestly styles himself a "layman," although he is really a very accomplished field naturalist, and probably knows more about the big game of North America than any other man. In this article the arguments are temperately, but forcibly put, the author laying stress on some of the points alluded to above, and urging that in the case of closely allied forms varietal or subspecific names should be employed in place of specific ones. Thus, the Asiatic wapiti should be a subspecies of the true wapiti, when its name (*Cervus canadensis eustephanus*) would at once indicate ts relationship. With regard to the use of specific names for what are essentially modifications of one and the same type of animal, Mr. Roosevelt writes as follows. "New terminology is a matter of mere convenience, and it is nothing like as important as the facts themselves. Nevertheless terminology has a certain importance of its own. It is especially important that it should not be clumsy or such as to confuse or mislead the student. Although species is a less arbitrary term than genus, still it remains true that it is more or less arbitrary. If one man chooses to consider as species what other men generally agree in treating merely as varieties, it is unfortunate, both because the word is twisted away from its common use, and

further because it confuses matters to use it in a new sense to the exclusion of the word commonly used in that sense. Moreover, it is a pity, where it can be avoided, to use the word so that it has different weights in different cases."

After calling attention to the great confusion and difficulty caused by the multiplication of species in genera which, in any case, contain a large number of specific forms, Mr. Roosevelt proceeds to make some very important remarks concerning genera which contain only one or two forms. He observes that—"The points of resemblance between beasts like the wolverines, the beavers, and the moose of the two northern continents are far more important than the points of difference. In each of these cases it does not much matter whether these animals are given separate specific rank, because in each case the Old World and the New World representatives make up the whole genus; but even here it would seem to be a mistake to separate them specifically unless they are distinguished by characters of more than trivial weight. The wapiti and Scotch red deer, for instance, are markedly different, and the differences are so great that they should be expressed by the use of specific terms. If the American moose and the Scandinavian elk are distinguished by specific terms of the same value, then it ought to mean that there is something like the same difference between them that there is between the red deer and the wapiti; and, as far as our present knowledge goes, this is not so. The wolverines, beavers, and moose of the two continents should only be separated by specific terms if the differences between each couple are of some weight, if they approximate to the differences which divide the red deer and the wapiti, for instance; and I know that even these two may intergrade."

With these sentiments we most cordially agree. Although we may prefer to regard each of the couples referred to as constituting only a single species, the harm done by dividing them is comparatively slight, not only, as Mr. Roosevelt states, because they are the sole representatives of their respective genera, but also from the fact that the members of each pair have the same English title; thus at once indicating their relationship and distribution.

If it be admitted that it is advisable to distinguish closely related forms from those more widely separated by means of nomenclature, the next question is whether it is preferable to do this by means of subgenera or subspecies. To illustrate this the case of the deer may be cited. By many writers of the present day the genus *Cervus* is taken to include all the deer furnished with brow-antlers, of which the wapiti is the only American representative. In this sense the genus may be split up into several subgenera, such as the Red Deer and Wapiti group (*Cervus*), the Japanese Deer group (*Pseudaxis*), the Fallow Deer group (*Dama*), the Sambar group (*Rusa*), and the Swamp Deer group (*Rucervus*) If we admit numerous species, we have in the first group the Red Deer (*Cervus elaphus*), the Barbary Deer (*C. barbarus*), the Maral (*C. maral*), the Wapiti (*C. canadensis*), the Asiatic Wapiti (*C. eustephanus*), &c. In the fourth we have the Sambar (*C. unicolor*), the Equine Deer (*C. equinus*), the Rusa (*C. hippelaphus*), the Hog Deer (*C. porcinus*), &c. Now, in the first group the Red Deer and the Maral are very closely allied, as are the true and the Asiatic Wapiti, and to retain these as species, and at the same time to express their true relationships, it is necessary to restrict the term *Cervus* to the Red Deer group, and to take the subgenus *Strongyloceros* for the Wapitis. This entails the raising of *Pseudaxis*, *Dama*, *Rusa*, &c., to the rank of genera. Similarly the Sambar, Equine, and Rusa Deer must form one subgenus of *Rusa*, and the Hog Deer a second. But this scheme has the disadvantage of splitting up the brow-antlered, or typical deer (*Cervus*) into several genera, which are much more closely related than is *Cervus* in its wider sense to the other usually accepted genera of the family, such as *Alces*, *Rangifer*, *Capreolus*, &c. We are, therefore, very little forwarder by this arrangement, by which we also lose sight of the fact that the brow-antlered deer (*Cervus*) are distributed over the greater part of the two northern continents, as well as India and the Malayan countries. On the other hand, if we adopt subspecies, the Maral becomes a subspecies of the Red Deer, as *C. elaphus maral*, and the Asiatic Wapiti of the true Wapiti as *C. canadensis eustephanus*, while the Equine and Rusa Deer respectively rank as subspecies of Sambar under the names of *C. unicolor equinus* and *C. unicolor hippelaphus*. Similarly, the Siberian ranks as a subspecies of the Indian tiger; while the brown and grizzly bears of Kamschatka and North America are ranked as subspecies of the European brown bear (*Ursus arctus*). Otherwise, the lion must be separated subgenerically from the tiger, and the brown and grizzly bears from the black bears. Which is the simpler, and, to most minds, the most philosophic arrangement, needs no mention!

Of course there are difficulties in such an arrangement, as there are in all sublunary matters; and in many cases there must and will be great difficulties in deciding as to what amount of difference constitutes a species and what a subspecies. But the same difficulty occurs when the term species is used in a more restricted sense. And it may be mentioned that even when so employed, subspecies are recognised by American writers. If it be necessary to indicate such "sub-subspecies," quadrinomials must apparently be employed, but these need only be mentioned for the benefit of the advanced specialist. The unfortunate thing in the matter is the existence of the "personal equation," which is one very difficult to get over. If, however, it be borne in mind when we have a large genus containing a number of well-defined types, around all or many of which cluster a series of closely related forms, that the term species be restricted to the former, while the latter are classed as subspecies, there ought in most cases to be no very great difficulty. In such an arrangement the amateur and the popular naturalist, as well as the student of geographical distribution in its wider and more important sense, can confine himself to the species, while the specialist can busy himself about the subspecies, or even the "sub-subspecies."

Possibly a greater latitude may have to be allowed to the students of the smaller mammals, such as the rodents, in which species may have to be based on slighter differences than are taken cognisance of in the case of the larger forms. Although perfect uniformity would be desirable, it is by no means absolutely essential that the same standard of distinction should be applied to all the groups.

As might have been expected, Dr. Merriam, one of the great champions of "splitting," has not allowed Mr. Roosevelt's challenge to pass in silence. And he has published a reply in *Science* of May 14, under the title of "Suggestions for a New Method of Distinguishing between Species and Subspecies." And here a moment's digression may be made to compliment both writers on the good feeling displayed in their criticisms—a marked contrast to some Transatlantic scientific disputations. Dr. Merriam states that hitherto he has taken the following as the distinction between species and subspecies, viz. that "Forms known to intergrade, no matter how different, must be treated as subspecies and bear trinomial names; forms not known to intergrade, no matter how closely related, must be treated as full species and bear binomial names." This is, of course, one of those hard-and-fast rules which look very nice on paper, but are not consonant with nature's system; for it is merely an accident whether the intermediate link is still existing, or has died out at a more or less remote epoch. In his new communication Dr. Merriam, for the first time, recognises the unimportance of the survival or extinction of the connecting link, and views with approval the proposal that our choice of binomial or trinomial nomenclature is to be governed by the *degree of differentiation rather than intergradation*. He expresses his new view as follows, viz. "In my judgment, forms which differ only slightly should rank as subspecies even if not known to intergrade, while forms which differ in definite, constant and easily recognised characters should rank as species even if known to intergrade."

It was not, of course, to be expected that Dr. Merriam would forthwith strike his flag, and admit that Mr. Roosevelt is right and himself wrong, but the giving up of the bugbear "intergradation" as a factor in the question at issue is undoubtedly a great point gained on the side of the "lumpers." It is, in fact, a clear admission that both species and subspecies are pure abstractions in the case of large genera, and that whether an animal is called one or the other is simply a matter of convenience. This being so, we may hope for the future to hear no more about such a creature being a "good" species.

The question of the distinction between species and subspecies is undoubtedly one bristling with difficulties, and it is therefore one which in many cases is incapable of being definitely settled by an individual opinion. Although personally convinced of the advisability of using specific names in a wide sense, and employing trinomials for the designation of the nearly related forms, it may be suggested that an international committee of zoologists should be formed to discuss the question

in all its bearings. Needless to say, such a committee should include representatives of both the "splitting" and "lumping" interests; and if the points at issue were fairly debated, with a full determination to give and take on both sides, it is difficult to believe that a working compromise between the extreme views could not be arranged. Almost anything is better than the present condition of uncertainty and discrepancy.

R. LYDEKKER.

RECENT INVESTIGATIONS INTO THE NUMERICAL VALUE OF "THE MECHANICAL EQUIVALENT."

THE value of the "mechanical equivalent," when deduced from experiments based on the direct transformation of mechanical work into heat, affords the best standard by means of which to test the validity of our system of electrical units. It is evident, however, that the value of this test depends upon the accuracy of the "equivalent" determinations. The engineer may (very rightly) regard extreme numerical accuracy in this case as comparatively unnecessary, but from the physicist's point of view there are few natural constants whose exact determination is of equal importance.[1]

Until the present time the evidence available has been so conflicting that it has been impossible to draw any certain conclusions from a comparison of the heat developed by mechanical work with that resulting from work electrically performed.

In *Phil. Trans. Roy. Soc.*, 1893, I gave an account of an investigation, by electrical methods, into the capacity for heat of water. The chief object of that work was to apply to the electrical units the test above referred to, for I considered that Rowland's admirable series of experiments (*Proc. American Academy*, 1879) on the direct conversion of mechanical energy supplied sufficient data to render such an investigation desirable. I regret, however, to say that, for the following reason, the results of that work have hitherto been of little value for the particular purpose for which it was undertaken. The change in the capacity for heat of water indicated by Rowland differed materially from that obtained by means of the electrical experiments. This difference in the rate of change must be due to differences in temperature measurements. In *Phil. Trans*, 1893, p. 496, I wrote as follows: "No change in the value of the various units or constants involved in our investigations could bring our results into absolute agreement with those obtained by Rowland, since, owing to the difference in the expressions for the temperature coefficients for the specific heat of water, it is inevitable that if our conclusions should agree at some one temperature, they must necessarily differ when expressed in terms of a thermal unit at any other temperature, and thus changes in the values of the units would only alter the temperature of agreement."

This quotation will, I think, render evident that but little progress could be made until some explanation of the discrepancies in the temperature measurements was forthcoming.

An indirect comparison of Rowland's standard with that of the Bureau International is given in Prof. Schuster's paper on the "Scale value of Dr. Joule's thermometers" (*Phil. Mag.*, 1895). The results indicate that Rowland's rate of decrease in the heat capacity of water would be diminished if expressed in terms of the International Standard; but, as Prof. Schuster remarked, "it would be necessary to have further information before any definite conclusions could be drawn."

I am glad to say that we are now in possession of the further information sought for by Prof. Schuster, and the above brief statement of our difficulties has been made in the hope of drawing attention to the new light now thrown on the whole subject.

[1] It has been decided (see Report of the Electrical Standards Committee, 1896) that the thermal unit is to be a dynamical one, hence the demand for accuracy becomes insistent.

Two entirely distinct investigations have just been brought to a successful conclusion in the laboratory of the Johns Hopkins University.

(1) "A recalculation of Rowland's value of the mechanical equivalent of heat in terms of the Paris hydrogen thermometer," by W. S. Day.

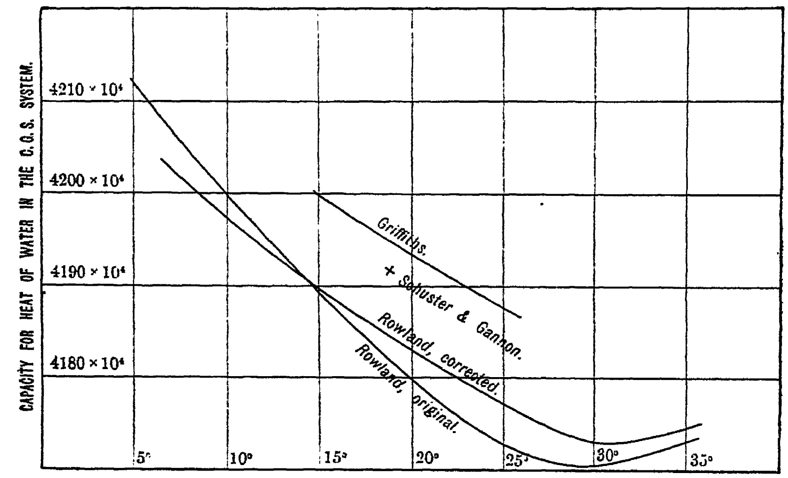
(2) "A comparison of Rowland's mercury thermometer with Griffiths' platinum thermometer," by C. W. Waidner and F. Mallory.

Both the above investigations have been carried out under the directions of Profs. Rowland and Ames. Full particulars of the work will shortly be published in America; but, in the meantime, the authors have very kindly given me permission to publish the results in this country. I will here give no details beyond the statement that the comparison of Rowland's thermometers with those of the Bureau International were made under conditions as nearly as possible similar to those prevalent during Rowland's experiments, and the same remark holds good with regard to the comparison with the platinum standard.

The results of these entirely separate investigations may be briefly summed up as follows:—

(1) The values resulting from Rowland's experiments undergo considerable modification at certain temperatures.

(2) Over the temperature range covered by Griffiths' experiments (14° to 26° C.), the rate of change in the capacity for heat of water becomes practically identical with that given by Griffiths.



(3) Throughout this range, Griffiths' value exceeds Rowland's by about 1 in 420.

(4) Separate standardisations of the same platinum thermometer were performed both in England and in America. The units adopted in the two cases differed slightly, but this is unimportant, as the temperature measurements are independent of the magnitude of the unit. The essential point is the respective values of the ratio of the resistance at 100° C. to that at 0°. These were as follows:

English	= 1·38596
American	= 1·38597

Thus affording satisfactory proof that not only the electrical measurements, but also the barometric standards, &c., are in perfect agreement.

(5) The results of the comparison with the platinum standard are (in the words of the authors) "in almost absolute agreement" with those deduced by Mr. Day from the direct comparison with the international standards, and thus the validity of Callendar and Griffiths' method of standardising the platinum thermometer is confirmed.

In the reduction of Rowland's results, "each individual experiment, the thermometers used in it, and the number of observations made with each thermometer, were taken into account.'

The results of all this labour are shown by the diagram (p. 258), and also by the following table.

Temp.	Old.	Corrected.	Griffiths.
10°	... 4200×10^4	... 4197×10^4	
15	... 4189	... 4189	... $4199{\cdot}7 \times 10^4$
20	... 4179	... 4183	... 4193·2
25	... 4173	... 4177	... 4187·4
30	... 4171	... 4173	
35	... 4173	... 4174	

Prof. Schuster and Mr. Gannon did not extend their determinations over any appreciable temperature range, and it is impossible, therefore, to apply the "rate of change" comparison to their results. Their thermometry, however, was directly based on the International Standard, hence it is probable that we now have *three separate determinations of the "mechanical equivalent" in which the temperature scale is identical.*

It appears to me that the data now at our disposal justify the following conclusions :—

(*a*) That the rate of change in the capacity for heat of water from 10° to 25° C. may be considered as known with sufficient accuracy for present purposes.

(*b*) That the persistent difference in the capacity for heat of water, when determined by mechanical and electrical methods, indicates a possibility that there is some error in one of the electrical units.[1]

One further matter deserves attention, concerning which there has hitherto existed considerable uncertainty, viz. the value of

the ratio $\dfrac{\text{“mean thermal unit”}}{\text{thermal unit at } t^{\circ}}$.

The value of this ratio is of great importance, as in the absence of exact information on this point we are unable to utilise the results of many notable experiments, such as those performed with Bunsen's calorimeter.

Until recently Regnault's value (1·005 in terms of the thermal unit 0° to 1°) has been universally adopted.

Some experiments performed by me in 1894, on the latent heat of evaporation of water, led to the conclusion that "the value of the 'mean thermal unit' is practically identical with that at 15° C." (*Trans. Roy. Soc.*, 1895, p. 320).

On the publication of this statement, Dr. Joly performed some experiments, from which we obtain the value ·9962 in terms of the thermal unit at 15° C. (*Phil. Mag.*, November 1895, p. 440), assuming Rowland's uncorrected values from 0° to 15°.[2]

In the Report of the Electrical Standards Committee, 1896, Mr. Shaw gives the results of a recalculation of Regnault's numbers, in which, assuming Rowland's uncorrected values, he obtains 1·0016 in terms of the thermal unit at 10°.

The enumeration of these facts indicates the extent of our uncertainty, and here again recent investigations lead us on to firmer ground.

In the Bakerian lecture delivered by Prof. Osborne Reynolds, on May 20, 1897, he communicated the results of an investigation by Mr. Moorby and himself into the value of the "mean thermal unit." Their results are of peculiar importance because they are practically independent of temperature measurements, and also on account of the large scale on which they were conducted. Their conclusion is "776·94 mechanical units at Manchester." I take this as equal to 777·07 at Greenwich = 4184×10^4 ergs. This is about equal to Rowland's corrected value at 19°, or, expressing it in terms of Rowland's corrected value at 15°, we get ·9988, which is sufficiently near to unity to justify my prediction as to the practical equality of the two units.

I trust that the above short summary will suffice to show that great advances have recently been made, and I venture to express a hope that the importance of extreme accuracy with regard to thermal measurements may, in the future, be more generally recognised than, I believe, has been the case in the past.

E. H. GRIFFITHS.

[1] For example, an error of 1 in 1000 in the electro-chemical-equivalent of silver would account for nearly the whole of our present discrepancies.

[2] I find that if we take Rowland's corrected values, this number approximates to ·9975.

THE ACTION OF LIGHT ON DIASTASE.

THE influence of the different rays of the solar spectrum upon the various phenomena of vegetable life has been shown by many observers to be not at all uniform. Speaking broadly, the rays lying to the left of the green, often collectively termed those of the red end, have been found to be most actively concerned with the metabolic processes. They are the ones on which generally the working of the chlorophyll apparatus depends, and in their absence no construction of carbohydrates from the carbonic anhydride of the air takes place. The rays beyond the green to the right, including also the ultra-violet ones, have, on the other hand, been shown to play but a small part in such constructive processes, but to be those on which the phenomena of heliotropism and other interferences with growth depend. They are broadly associated, therefore, with the physical rather than the chemical processes.

In recent years the influence of the blue, violet and ultra-violet rays has been found to be deleterious to vegetable protoplasm, exposure to them destroying many micro-organisms. They have further been shown to share, though to a small extent only, the power of assisting the chlorophyll apparatus. Some time ago a research of considerable importance was conducted by Messrs. Brown and Morris, from which it appeared that the amount of diastase obtainable from foliage leaves varies considerably at different periods of the day, being greater after darkness, and diminishing after exposure to light. An investigation of the action of the different rays of the spectrum on diastase has recently been carried out by Prof. Reynolds Green, which shows that its separate regions possess radically different powers, and that while some rays are beneficial and aid in the secretion of the enzyme, others are as distinctly deleterious and, indeed, affect the diastase in the same way as those of the blue end do the micro-organisms already spoken of.

By the use of appropriate screens the spectrum was divided into seven bands, the infra-red, the red, including the rays of wave-length $720\mu\mu$ to $640\mu\mu$; the orange, ranging from $640\mu\mu$ to $585\mu\mu$; the green, from $585\mu\mu$ to $500\mu\mu$; the blue, from $500\mu\mu$ to $430\mu\mu$; the violet, including the visible rays beyond wave-length $430\mu\mu$; and the ultra-violet.

Solutions of diastase, prepared from malt extract, and from the leaves of *Phaseolus vulgaris*, as well as from human saliva, were exposed to strong illumination, either that of the sun, or of a strong naked electric arc-lamp, for several hours, and after such exposure their hydrolytic power was tested side by side with that of control solutions that had not been illuminated. By the use of the screens already mentioned, the effects of these several regions of the spectrum were ascertained.

Of the infra-red, red, orange and blue regions the rays were found to have a distinctly beneficial effect upon the manufacture of the enzyme. The effect was, however, much the greatest in the red region, these rays, when allowed to act for ten to twelve hours, increasing the amount of diastase by one-half. A second maximum was obtained in the blue, while the rays of the other regions were intermediate in power.

The violet and ultra-violet rays were ascertained to exert a destructive action on the enzyme, an exposure of ten to twelve hours to the latter especially, often resulting in the destruction of 60 per cent. of the diastase. The change set up in the solution was found to be a continuous and progressive one, the extract becoming weaker after removal from the action of the light until the diastasic power entirely disappeared.

This effect was found to follow also a strong illumination of the living leaf. Leaves of *Phaseolus* were exposed to sunlight and the electric arc respectively, half of each being carefully shaded by a cover of blackened paper. After the illumination, weighed quantities of the shaded and unshaded sides were made to act under the same conditions upon a solution of starch, when the hydrolytic power of the unscreened portions was found to have been very materially injured.

The difference in the action of the various rays suggests a modification of the view that the chemical action of light in vegetable metabolism is particularly a property of the red end of the spectrum. This is borne out further by some experiments recently published by Laurent, who has found that the blue and violet rays are especially active in the construction of nitrogen-containing compounds in the plant. All the rays appear to be able to bring about chemical effects, the differences depending upon the materials taking part in the reactions, rather than upon any radical differences in the nature of the light.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Great Hall of the Northern Polytechnic Institute is being opened to-day (Thursday) by the Lord Mayor.

THE Rev. Dr. Thorburn, formerly Science Master in the Royal Grammar School, Sheffield, has been appointed Head Master of the Grammar School, Odiham, Hants.

THE sum of 2000*l.* has been offered to the Smith College for the erection of a building for the scientific laboratories, on condition that the sum of 1800*l.* is subscribed by the alumnæ.

DR. KARL TOLDT, Professor of Anatomy in the Medical Faculty of Vienna, has been elected Rector of the University for the Academic year 1897-98.

MR. C. A. MORTON and Dr. J. Swain have been appointed joint Professors of Surgery in the Faculty of Medicine of University College, Bristol.

A DONATION of 2500*l.* has been promised by Mr. A. F. Calvert to the funds of the proposed North-Western Polytechnic (St. Pancras and Hampstead).

ACTING on the recommendation of the Faculty of Physicians and Surgeons, Columbia University, the chair of Chemistry and Medical Jurisprudence (at present vacant) has been changed to that of Physiological Chemistry.

THE tenth session of the Marine Biological Laboratory, Wood's Holl, Mass., began on July 6, and is to last for six weeks. It is being conducted by Dr. B. M. Davis, of the University of Chicago, and two courses are offered, (1) on Elementary Botany, and (2) on the Morphology of the Algæ.

THE late Mr. J. S. Taylor, of Edderton, near Ross, left 4000*l.* in trust to found bursaries or scholarships to be known as the "John Taylor bursaries," to be competed for by natives of Thurso desiring to complete their education at Edinburgh University. He also bequeathed 1000*l.* to the Tain Academy, Ross-shire.

Science states that an anonymous donor has presented to the library of Columbia University 387 books, valued at about 1200*l.* They include a number of valuable works in natural history, such as Audubon's "Quadrupeds," Sepp's "Nederland'sche Insekten," Gould's "Humming-Birds," and Levaillant's "Oiseaux d'Afrique."

UNDER the will of Mrs. Gee, widow of the late Mr. Robert Gee, lecturer on the diseases of children in the medical school associated with University College, Liverpool, that college receives over 7000*l.* for the purpose of advancing the medical department, and promoting study and research in medical science. It has been decided by the medical faculty to institute a Robert Gee fellowship in anatomy of the value of 100*l.* for one year, and four entrance scholarships of 25*l.* each for one year.

THE following appointments are announced:—Dr. Thomas S. Fiske, of Columbia College, has been made a full Professor of Mathematics; Dr. Wm. Slocum, at present President of Colorado College, has been elected President of Oberlin College; Dr. G. Boccardi has been appointed Associate Professor of Microscopical Anatomy at the University of Naples; Dr. J. Szadowski, Associate Professor of Geology at the University of Klausenberg; and Dr. J. J. Zumstein to be Professor of Anatomy at the University of Marburg.

A MEETING of the subscribers to the Hall Memorial Fund, which was started a few months ago to commemorate the jubilee of science teaching at the City of London School, was held at the school on Monday last. It was announced that the amount subscribed (including 100 guineas from the Corporation) was about 354*l.*, and it was resolved that 350*l.* should be devoted to founding a scholarship to promote the study of chemistry and physics in memory of the late Mr. T. Hall, science master at the school, 1847-1870. The scholarship is to be awarded every fifth year, and to be tenable for two years.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xix. 3.—Development of the A-process in quaternions, with a geometrical application, by Dr. J. B. Shaw, gives several interesting results.—On the analytic theory of circular functions, by A. S. Chessin. The writer points out that the similarity between simply and doubly periodic functions ceases to exist when the behaviour of the function at infinity comes to be investigated. He refers to M. Méray's "Leçons nouvelles sur l'Analyse infinitésimale et ses applications Géométriques," wherein is given a classification of simply periodic functions into *polarised* and *non-polarised* functions. He then states that the character and *rôle* of the *polar values* of a circular function have not been clearly set forth, and that the object of his paper (pp. 216-258) is to supply the deficiency.—Sur un problème concernant deux Courbes Gauches. by Prof G. Kœnigs. The problem, of which a *direct* solution is given, is "une Courbe C étant donnée, en trouver une autre C, qui lui corresponde point par point de sorte que le plan osculateur à chaque courbe aille passer par le point qui correspond sur l'autre au point de contact."—The object of a second paper, by Dr. Shaw, entitled "The Linear Vector Operator of Quaternions," is the development of the linear vector operator, entirely from a quaternion point of view, which amounts, the author writes, to an extension or development of nonions; reference is made to a paper by Dr. H. Taber in vol. xii. of the journal.—On certain applications of the theory of probability to physical phenomena, by Dr. G. H. Bryan. This is a subject to which much has been contributed in our columns. Dr. Bryan arrives at the conclusion that even the theory of probability does not furnish us with a *conclusive* proof of the Boltzmann-Maxwell law. That the law in question represents accurately the state of the molecules in a perfect gas, and approximately their state in an ordinary gas, cannot be doubted; but directly we attempt to generalise the law by applying it to assemblages of densely crowded molecules, we are confronted with the necessity of making some assumption or other, and the above treatment (*i.e.* employed in Dr. Bryan's note) shows that even probability considerations do not afford a sure way out of the difficulty.

MESSRS. W. AND G. S. WEST's paper on Welwitsch's African Freshwater Algæ is still occupying the pages of the *Journal of Botany*, with the description of a large number of new and interesting forms. In the numbers for June and July descriptions are given of the following new genera: *Athroocystis*, belonging to the Palmellaceæ; *Camptothrix*, the type of a new order, *Camptotricheæ*, of Cyanophyceæ; *Polychlamydum*, near to *Schizothrix*.—Mr. E. G. Baker describes and figures the variety *ceratophyllon* of *Plantago coronopus*, new to Britain.—Mr. Arthur Lister has some notes on rare species of Mycetozoa, in which several new species are described.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 17.—"On the Distribution of Frequency (Variation and Correlation) of the Barometric Height at diverse Stations." By Prof. Karl Pearson, F.R.S., University College, London, and Miss Alice Lee, B.Sc., Bedford College.

This paper is especially intended as an *illustration of method*. The authors believe that hitherto no exact theory of variation or of correlation has been applied to meteorological observations, and they have endeavoured to indicate that fruitful results may be obtained from such a theory when applied to one branch at least of meteorology, namely, barometric frequency.

Their first object was to determine the nature of the barometric frequency distribution. By means of tables and plates it is shown that it can be described with a very high degree of accuracy by the use of a generalised frequency curve of the type—

$$y = y_0\left(1 + \frac{x}{a}\right)^p e^{-\gamma x},$$

a type which has been fully discussed in a previous memoir on skew variation.

A standard frequency curve for the British Isles having been selected, it is shown that the frequency distribution varies continuously from this type as we pass from station to station, and appears to be fairly uniform along lines which are termed generalised isobars.

The authors' next object was to discover what constants of the barometric frequency suffice to describe it with the least probable error. A somewhat elaborate investigation was accordingly made into the probable errors of the constants, and four *physical* quantities, the mean, the variation (or standard

deviation), the skewness, and the modal frequency were found to be the constants, which described a local barometric frequency with the smallest probable errors.

They have next discussed the chief physical features of a barometric frequency distribution.

(*a*) The modal height and the modal frequency are found to possess certain advantages over the mean height and the mean frequency. Various methods are considered for approximately determining the position of the mode.

(*b*) The variability of the barometric height and the skewness of the distribution are discussed at some length.

(*c*) A test of the accuracy of the observations for the twenty coast stations is made by attempting an interpolation of the frequency constants of London and Cambridge between those of Southampton, Hillington, and St. Leonards.

In the second part of the memoir the subject of correlation is dealt with. It is shown that within the limits of the British Isles there is a very high degree of correlation (as high as 0·9824 between Babbacombe and Churchstoke), and only sinking to 0·7572 if we take practically the utmost reach of the British Isles. It is pointed out that the gradual change of correlation with direction and distance, combined with change owing to the interval of time between observations, enables the meteorologist to find systems of stations with almost every variety of correlation coefficient.

The probable height and probable deviation from that height at any given station, based on a knowledge of the heights, contemporaneous or not, at one, two, three, or more other stations, are considered. It is indicated that with proper arrangement of times and distribution of stations it must be possible to make the probable deviation zero or nearly zero, and hence to predict with very great accuracy the height at one station from a knowledge of heights at other selected stations. The suggestion is made that this principle might very possibly be applied to closely predict future barometric heights at a given station from antedated observations at other selected stations.

Various theorems are deduced from the general principles of correlation: thus, it is shown that—

(*a*) There is a balance height for every pair of stations, such that when the barometer stands above this height at one station it will usually stand below it at the other, and *vice versâ*.

(*b*) That for a very considerable number of triplets of stations which are positively correlated together, so that a high barometer at one means usually a high barometer at a second, it can still be predicted that if the barometer be steady at one, a rise or fall at the second denotes a fall or rise respectively at the third member of the triplet.

The writers hope that their paper may draw attention to the importance of rendering the large amount of barometric observations now made, available for the easy calculation of the variation and correlation coefficients. They consider that if a chain of stations round a large continental area could have their correlation for a series of intervals of time worked out, much might be done in the way of very close prediction of barometric changes.

"On the Theory of the Magneto-Optic Phenomena of Iron, Nickel, and Cobalt." By J. G. Leathem, Fellow of St. John's College, Cambridge. Communicated by Sir Robert S. Ball, F.R.S.

In this paper the fundamental equations of a particular type of magneto-optic theory are taken in a general form on the lines of Mr. Larmor's recent papers on electro-dynamics, and developed so as to obtain the solutions of the problems of magnetic reflection and of transmission through films. The formulæ so obtained are compared with the available experimental results.

The notation differs slightly from that of Maxwell: C denotes the velocity of radiation, and (f'', g'', h'') corresponds to Maxwell's total electric displacement; this has components (f, g, h) and (f', g', h'), of which the former is the displacement involved in the ether strain, and the latter that involved in the polarisation of the matter. It being assumed that for light oscillations the magnetic permeability is unity, the fundamental equations of the theory are as follows: (i.) The circuital relations $dc/dy - db/dz = 4\pi u$ and $dR/dy - dQ/dz = -da/dt$. (ii.) The equations of the current $u = \sigma P + g_3 Q - g_2 R + df''/dt$, where the vector (g_1, g_2, g_3) represents the Hall effect. (iii.) The displacement relations, and the elastic relations between electromotive force and polarisation, viz. $f'' = f + f'$, $f = P/4\pi C^2$, and $f' = (K - 1)/4\pi C^2 . P + b_3 dQ/dt - b_2 dR/dt$, the vector (b_1, b_2, b_3) representing, in transparent matter, the whole magneto-optic effect.

The vector $\{(b_1 d^2/dt^2 + g_1), (b_2 d^2/dt^2 + g_2), (b_3 d^2/dt^2 + g_3)\}$ is assumed equal to $C_0 e^{\iota x} (\alpha_0, \beta_0, \gamma_0)$, where $(\alpha_0, \beta_0, \gamma_0)$ is the intensity of magnetisation; and $C_0 e^{\iota x}$ is the single magneto-optic constant of the theory.

The principal experiments made use of are those of Drs. Sissingh and Zeeman on magnetic reflection, their observations being measurements of the phase m and amplitude μ of the "magneto-optic component" of the reflected light for various angles of incidence.

The following table will serve to indicate what sort of agreement is found to exist between the theory and the experiments.

Equatorial Reflection from Iron.

Angle of incidence.		Observed value of m.		Calculated value of m.
° ′		° ′		° ′
86 0	...	209 26	...	272 35 − x
82 30	...	204 22	...	265 19 − x
76 30	...	194 49	...	256 31 − x
71 25	...	190 3	...	251 13 − x
61 30	...	181 49	...	244 18 − x
51 22	...	179 0	...	239 48 − x
36 10	...	174 9	...	235 27 − x

If the value of x is about 62°, the agreement shown is remarkably good. Experiments on polar reflection from iron point to almost exactly the same value for x.

If we suppose the value of C_0 to be given by

$$-C_0 = 7 \cdot 283 \times 10^{-11},$$

the ratios of the calculated to the observed values of μ for the above angles of incidence are found to be respectively 1·13, 0·96, 0·99, 0·97, 1·01, 1·03, and 0·97; so that in the case of the amplitudes also there is good agreement.

The theory gives a satisfactory account of a phenomenon which has only recently been discovered, namely, an effect of the component of magnetisation perpendicular to the plane of incidence. Good agreement is also found to exist in the case of the experiments on transmission through films.

It is to be noticed that, as b_1, b_2, b_3 are necessarily real, the imaginary part of $C_0 e^{\iota x}$ must be entirely accounted for by the Hall effect. Hence the present theory involves the supposition that the Hall effect is very much greater for rapidly alternating currents than for steady ones.

"On the Change of Absorption produced by Fluorescence." By J. Burke, M.A. (Dub.).

A careful series of experiments which have led to the result that certain fluorescent substances—notably uranium glass—absorb the rays which they give out whilst fluorescing differently, according as they are in a state of fluorescence or not; so that if a body, A, of some fluorescent substance, such as uranium glass, be transmitting light from a similar body, B, which is fluorescing the amount of light transmitted by A from B, is quite different, according as A is fluorescing or not.

If α and β are the coefficients of transmission in the two cases for uranium glass 1 cm. thickness, the mean values obtained by eye observation are $\alpha = 0 \cdot 47$; $\beta = 0 \cdot 79$.

The ratio $\dfrac{\beta}{1 + \alpha}$ was also independently determined, the mean value of which $= 0 \cdot 507$. The values of α and β determined photographically were

$$\alpha < 0 \cdot 48 \qquad \beta > 0 \cdot 75$$
$$> 0 \cdot 43 \qquad < 0 \cdot 89$$

In the determinations of α and β, a null method has been employed, by which any appreciable want of uniformity in the illumination could be detected.

The source of illumination was almost invariably the spark discharge of a Leyden jar between cadmium electrodes, being one of the richest sources of the fluorescence exciting rays, and the photometer one specially constructed for the purpose.

The phenomenon has been exhibited directly by obtaining two photographs side by side upon the one plate: one the effect of the fluorescence due to two layers of the fluorescent substance; the other the result of superposing the effects due to the fluorescent light from a single layer according as it came directly or through a non-fluorescing layer of equal thickness. The exposures being equal in each of the three cases, the superposed photographic effect was greater than the other one,

notwithstanding the fact that the result of superposing two nearly equal effects due to light of the same intensity—or nearly so—had been found not to be equal to, but less than that due to light of double the intensity acting for half the time. If the resultant effect were equal to the sum of the separate ones, the effect caused by the change of absorption would have been still more marked.

The effect can also be shown by the photometer, for if $a = B$, taking the maximum value of $a = 0{\cdot}48$, the ratio $\frac{a}{1+a} = 0{\cdot}32$, and instead of obtaining equality when the photometer is adjusted for this value the difference is most marked.

"On the Relative Behaviour of the H and K lines of the Spectrum of Calcium." By William Huggins, D.C.L., LL.D., F.R.S., and Mrs. Huggins.

The problem before us was to find out by experiments in the laboratory, under what conditions the lines of calcium other than the lines H and K, and in particular the strong blue line at 4226·9, were so greatly enfeebled relatively to H and K, that they became quite insignificant, or even disappeared altogether from the spectrum, leaving the very simple spectrum of the two lines H and K, or nearly so.

It was suggested to us by the known rarer state of the gases in the regions above the photosphere, as well as by my long experience with the behaviour of calcium in comparison spectra, that the modifications of the calcium spectrum which we were seeking, would be likely to show themselves under conditions of greatly reduced density of the calcium vapour.

For obvious reasons we elected to use throughout the experiments a spark of very small intensity.

Our expectations were completely confirmed. Under the conditions (*a*) of greatest density of the calcium vapour, when metallic calcium was employed, the blue line was as strong and possessed the same diffuse character as H and K.

As the density of calcium was reduced, the lines were not found to be equally enfeebled, but, on the contrary, the blue line and the greater number of the lines were increasingly reduced in intensity relatively to H and K, until at last with the twice washed electrodes (*d*) the spectrum was simplified to the condition usually existing in the prominences, in which H and K only are present.

A more precise statement of the changes of relative intensity as they are presented in the photographs on the plates are given in the paper.

The only condition which was varied during this set of experiments was the amount or density of the calcium vapour. The changes of relative intensity, and the modifications of the calcium spectrum produced thereby, correspond closely to the behaviour of calcium at different levels near the sun's limb, and in the atmospheres of stars of different orders. There can remain little doubt that the true interpretation of the changes in appearance of the calcium lines in the celestial bodies is to be found in the different states of density of the celestial gases from which the lines are emitted or by which they are absorbed.

In the modifications of the calcium spectrum arising from variations in the relative intensities of the lines which have been discussed in this paper, and which correspond to those observed in the celestial bodies, there does not appear to us any reason for assuming, much less any direct evidence in favour of, a true dissociation of calcium, that is, of its resolution into chemically different kinds of matter.

A letter from Prof. Liveing is added, which contains an account of early experiments on the spectrum of calcium which support, by a different method of working, the conclusions of our paper; and seem to show the possible occurrence of the line H without K. In our experiments both H and K were always present, K being stronger than H, as is the case in the photographs of the prominences by Hale, and by Deslandres.

"Stress and other Effects produced in Resin and in a Viscid Compound of Resin and Oil by Electrification." By J. W. Swan, F.R.S.

In this paper are described the stress and other effects produced by non-luminous electrical discharges on a viscid mixture of resin and oil. Wires from the discharging terminals of an induction coil or Wimshurst machine were led, one above and the other below a glass dish containing the resin mixture. The terminal above the resin surface was usually a point, ball, or disc, and the one below was a disc, forming a support for the dish of resin. The discharging arms of the coil were used as a spark gap. The spark, 25 to 50 mm. long, always passed at the spark gap, the terminals above the resin being so adjusted that the resistance to discharge was slightly greater there than at the spark gap. When the upper terminal is a ball, and connected to the + electrode, then on a spark passing at the spark gap there is produced on the surface of the viscous mixture a star-shaped figure, formed of deeply-furrowed, closely-clustered, outward-branching rays, extending from a circular frill near the centre to the margin of the dish. The figure gradually dies down, and when the surface is smooth it may be produced again and again.

If the terminal above the resin surface be made − instead of +, then on a spark passing at the spark gap, a figure characteristic of the − discharge is produced. This figure is much smaller and weaker than the + one; most frequently it consists of a circular band or ring, more or less indented in outline, enclosing leaf-like rays which tend towards the centre. These are relatively broader and less branching than the + rays, and are in relief, while the + rays are below the plane of the surface. When the electrification is strong, the ring enclosing the rays stands up as a frill in considerable relief. These figures closely resemble the dust figures obtained by Lichtenberg and Armstrong.[1]

The character of the figures depend on

(1) Whether the terminal over the dielectric is + or −.
(2) The form and size of the + and − terminals.
(3) The distance of the upper terminal from the surface of the dielectric.
(4) The character of the spark at the spark gap.
(5) The density of the atmosphere.

Permanent figures may be obtained by substituting ordinary hard resin for the viscous mixture. The figures are then developed by warming and rendering the surface sufficiently plastic to allow of movement. The persistence and fixity of the stresses produced by a discharge on resin is remarkable, figures have been developed two months after the discharge with very slight diminution of effect.

The density of the atmosphere exercises a great effect on the figures obtained. As the density diminishes, the figures become more diffuse and less marked in character, and at an air pressure of 85 mm. a + figure becomes faintly marked by bands without the characteristic rays.

Geological Society, June 23.—Dr. Henry Hicks, F.R.S., President, in the chair.—Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894-96, by E. T. Newton, F.R.S., and J. J. H. Teall, F.R.S. A large collection of rocks and fossils, obtained by the members of the Jackson-Harmsworth Expedition, chiefly from the neighbourhood of Cape Flora, on the south-west of Northbrook Island, but also from more distant localities visited during boat- and sledge-journeys, have been sent to the Director-General of the Geological Survey, and examined by the authors. After a summary of what was previously known of the geology of Franz Josef Land, an account of the new specimens was given. The rocks are for the most part basalts, and are described in detail; they are usually formed of labradorite, augite, and interstitial matter which is sometimes represented by palagonite containing a large percentage of iron-oxide. This palagonite is regarded as the hydrated representative of the residual magma left after the separation of labradorite and augite; and the conclusion is reached that in this case progressive crystallisation has resulted in the concentration of iron-oxide in the mother liquor. Most of the fossils have been collected around Cape Flora. The presence of *Ammonites macrocephalus*, *A. modiolaris*, and *Belemnites Panderi* indicate the presence of rocks of Lower Oxfordian or Callovian age; while, apparently above these, a plant-bed was met with in which the genus *Ginkgo* is conspicuous, and this is believed to be of Upper Jurassic age. The oldest fossiliferous bed yet found occurs about twenty miles to the west of Cape Flora, and also contains plant-remains, which, it is thought, may be Lower Jurassic and possibly of the age of the Great Oolite. These plant-beds and numerous indications of layers of lignite seem to show that these Jurassic strata are to a great extent of estuarine or fresh-water origin. The general structure of the country appears to be typified by what occurs at Cape Flora, where cliffs of sedimentary strata some 600 feet high (for the most part hidden

[1] "Electric Movements in Air and Water, with Theoretical Inferences." By Lord Armstrong, C.B., F.R.S. (London: Smith, Elder, and Co., 1897.)

by talus) are overlain by 500 feet of basalt. At some other localities, however, the basalt is found at the sea-level. It is pointed out that the islands, which make up the archipelago of Franz Josef Land, are fragments of a formerly extensive region of plateau-basalts, similar to that of which the Færöe and the Western Isles of Scotland must have formed a part.—Deposits of the Bajocian age in the North Cotteswolds. I. The Cleeve Hill Plateau, by S. S. Buckman.—Pleistocene plants from Casewick, Shacklewell, and Grays, by Clement Reid.—An explanation of the Claxheugh Section (Co. Durham), by D. Woolacott.

PARIS.

Academy of Sciences, July 5.—M. A. Chatin in the chair.—The elections of M. Hatt, as Member of the Section of Geography and Navigation, and of M. de Lapparent, in the Section of Mineralogy, were confirmed by the President of the Republic.—Distribution of the velocities of gradually varied flow in tubes of large section, and the equation of the motion to a higher degree of approximation, by M. J. Boussinesq.—On the explosion of a manometer in a projection apparatus, by M. de Lacaze-Duthiers. The manometer in question had been used without accident on many previous occasions, and no explanation can be offered to account for its bursting, which was attended with serious injury to the lantern manipulator. The question was referred to a committee for investigation.—M. Virchow was elected a Foreign Associate of the Academy in the place of the late M. Tchebichef.—On the establishment of a general formula of interpolation for functions of any number of variables, by M. Dupont.—On the algebraic surfaces which admit of a skew cubic as an asymptotic line, by M. Ch. Bioche.—On the partial polarisation of luminous radiations under the influence of the magnetic field, by MM. N. Egoroff and N. Georgiewsky. The experiments show that the luminous intensity of a Bunsen burner always increases under the influence of a magnetic field. By the aid of a Wollaston prism it was found that a magnetic field partially polarises each of the rays of the sodium spectrum in two perpendicular planes. The fine lines of the metalloids, obtained by M. de Gramont's method, remain unchanged in the magnetic field.—The magnetic deviation of the kathode and X-rays, by M. G. de Metz. In a previous paper certain effects were attributed to the kathode rays, which M. Poincaré suggested might really be due to X-rays, the latter being possibly produced by the reflection of the kathode rays at a platinum surface. Preliminary experiments upon the behaviour of the reflected kathode rays towards a magnet tended to show that X-rays were not produced under these conditions, but further researches seem to indicate that the two classes of rays cannot be distinguished by their behaviour towards a magnet.—On the actino-electric effects of the Röntgen rays, by M. S. Puggenheimer. If two similar electrodes are plunged into a liquid and exposed to the Röntgen rays, a current is set up in the wire joining the plates, the intensity and direction of which depends upon the intensity of the radiation.—On a thermal ammeter containing mercury, by M. Charles Camichel. The bulk of a mercury thermometer is placed concentrically in a glass tube containing mercury; the current is passed through the latter for a definite time, and the rise of temperature read. It is shown that for a constant current the rise of temperature is constant, moderate variations of the air temperature being without effect upon the readings.—New mercury pump without taps or mobile joints, by M. H. Henriet. The pump figured appears to be practically identical with the original form of the Töpler pump, except that the side tube for admitting air without bumping to the vacuous vessel is omitted.—Action of tellurium chloride and fluoride upon the corresponding hydracids, by M. R. Metzner. The compounds $TeCl_4.HCl.5H_2O$, $2TeF_4.3TeO_2.6H_2O$, and $TeF_4.TeO_2.2H_2O$ were prepared and analysed.—Reduction of molybdic acid by hydrogen, by M. M. Guichard. Below 470° C. the reduction of MoO_3 to MoO_2 is continuous, no intermediate oxide being formed.—On the manganimolybdates, by M. E. Péchard. The potassium, sodium, and ammonium salts of a new complex acid containing manganese and molybdenum are described.—On veratrylenediamine, by M. Ch. Moureu. The new amine condenses with phenanthraquinone, acetic acid, and benzaldehyde.—On paraxylylacetic acid, by M. Guerbet.—Action of tannin and of gallic acid upon quinoline bases, by M. Oechsner de Coninck.—On a new carbohydrate, caroubinol, by M. Jean Effront. The new carbohydrate, which possesses the general formula of the celluloses ($C_6H_{10}O_5$) is extracted from the grains of *Ceratonia siliqua*.—On fermentation in media consisting of solid particles, by M. Th. Schlœsing, jun.—The potato, by MM. H. Coudon and L. Bussard.—Researches relating to the homology of the shoulder-bone in Batrachians and Saurians, by M. A. Perrin.—On the morphological signification of the hinge teeth in Lamellibranchs, by M. Félix Bernard.—The regeneration of the micronucleus in some ciliated Infusoria, by M. Félix Le Dantec.—Evolution of the parasite found in the cœlom of the house-cricket, by M. L. Cuénot. This parasite belongs to the genus *Diplocystis* (Kunstler). Two new species are described, named *D. minor* and *D. major*.—On the morphology of the compound larva of a Synascidian (*Diplosomoïdes Lacazii*, Giard), by M. Maurice Caullery.—On the hypodermal nuclei of the Anguillulidæ, by M. Joannes Chatin.—The true cause of the disease of the potato known as *Frisolée*, by M. E. Roze.—On a layer of syenite in the ground mass of Mount Genèvre, by M. W. Kilian.—Remarks by M. Michel Lévy on the preceding paper.—Experiments made with an aeroplane moved by steam, by MM. V. Tatin and Charles Richet.—On certain disturbances of the sea-level observed in the bay of Brusc, by M. Barthe de Sandfort.—Account of an apparatus for measuring the speed of boats or of sea-currents, by M. Merlateau.

NEW SOUTH WALES.

Linnean Society, May 26.—Prof. J. T. Wilson, President, in the chair.—Notes on the *Formicidæ* of Mackay, Queensland, by Gilbert Turner. Nearly one hundred and forty species have been collected, and with the kindly afforded help of Prof. Aug. Forel, of Zürich, identified, except in a few cases still under consideration. A general account of their habits and distribution was given.—Descriptions of two new species of *Cypræa* from West Australia, by Agnes Kenyon.—Notes from the Botanic Gardens, No. i., by J. H. Maiden and E. Betche. (*a*) Notes on rare Port Jackson plants, viz. *Siebera Stephensonii*, Benth., at Botany Bay and La Perouse; *Helichrysum adnatum*, Benth., at Oatley and Hurstville; *Acacia Baueri*, Benth., at the Centennial Park, and an almost glabrous form of *Eriachne obtusa*, R. Br., near Rose Bay. The authors also presented a note on the rare *Dodonæa filifolia*, Hook., showing that the doubt cast by Bentham in the "Flora Australiensis" on the correctness of the Sydney locality is now removed. (*b*) Plants new for New South Wales. These are *Acacia alpina*, F. v. M., from near Kiandra; *Pterigeron dentatifolius*, F. v. M., from Olive Downs, Grey Range; *Geodorum pictum*, Lindl., from Byron Bay.—Descriptions of three new Australian plants, by J. H. Maiden and E. Betche. (1) *Dodonæa Camfieldi*, a remarkable species belonging to Bentham's section "Cyclopteræ," but not closely allied to any described form. The leaves have broad sessile bases which appear to be unique in the genus, and the leaves have large groups of resin-secreting glands which give them a dotted appearance. (2) *Helipterum microglossum* (Syn. *H. corymbiflorum*, var. *microglossum*), differing in some important particulars from its so-called variety, between which there appear to be no intermediate forms. (3) *Leucopogon Fletcheri*, a species allied to *L. juniperinus*, from which it is chiefly distinguished by the pendulous flowers, the proportionately longer corolla lobes, and the exserted style.—Descriptions of two new Acacias from New South Wales, by R. T. Baker. Of the two species described, one is allied to *A. elongata*, Sieb., and the narrow-leaved variety of *A. subporosa*, F. v. M.; the other to *A. penninervis*, Sieb., and *A. retinoides*, Schl. Both are from the Rylestone District, the second of them, however, extending also to Cobar and Tocumwal.—On a larval Teleost from New South Wales, by J. Douglas Ogilby. The form described is conjectured to be the larva of one of the ophisuroid eels. Reference was made to Grassi's important researches on the Mediterranean Leptocephali or Glass-Eels; and to the insuperable difficulty which, in the absence of any biological station, effectually precludes the possibility of carrying out similar investigations on Australian forms.

AMSTERDAM.

Royal Academy of Sciences, April 21.—Prof. van der Waals presented, on behalf of Prof. Kamerlingh Onnes, two papers by Mr. E. van Everdingen, jun. (*a*) On the increase of the resistance of bismuth in connection with the dissymmetry of Hall's effect. Experiments with small bismuth bars cut, in different directions, out of the same piece of bismuth, show that the ratio of the amounts of resistance in those directions is modified in the magnetic field. This modification appears to

suffice to account for the sign and amount of the dissymmetry of Hall's effect. (*b*) On the relation between crystal direction and resistance, increase of magnetic resistance and Hall's effect. Hall's coefficient is not the same for a number of small plates, cut, in different directions, out of the same bismuth crystal. (The ratio of the maximum to the minimum value was once found to be nearly 8.) The amount of the increases of magnetic resistance in the plane $\perp$ magnetisation is determined by the same angle. (The ratio of maximum to minimum sometimes amounts to more than 2.)

May 29.—Prof. Korteweg, on certain oscillations of higher order and abnormal intensity that can occur in mechanisms of several degrees of freedom. It was shown that, under certain conditions some of the coefficients, and with them, also, the respective oscillations are of abnormal magnitude. The author developed the theory of these abnormal oscillations of higher order. He discussed the part they may perhaps play in the oscillations of a mechanism, in the theory of light, and also in the spectra of gases, if Prof. V. A. Julius's view, that the internal motion of molecules may be conceived as oscillations of moderate intensity about a state of equilibrium, be right.—Mr. Eykman, treating of measures for checking beri-beri, communicated the results of researches made by the Medical Inspector Vorderman, concerning the relation between the nature of the rice-diet and the occurrence of beri-beri in the prisons in Java. From these researches it appears that the disease occurs principally in those prisons where the rice is eaten completely peeled, and, on the contrary, hardly ever in those where the prisoners eat half-peeled rice (*i.e.* rice still covered with the "silvery" pellicle"). This inquiry was suggested by similar results obtained by the author when studying a disease of domestic fowls, resembling beri-beri.—Prof. van der Waals presented, on behalf of Mr. P. Zeeman, further observations by the author concerning the change of spectrum lines by magnetism. Along the lines of force a blue cadmium line was doubled, across the lines of force it was trebled by the action of magnetism, the polarisation of the middle and that of the edges of a broadened line in the latter case being perpendicular to each other. This is in perfect harmony with Lorentz's theory of the effect.—Prof. van der Waals next read a paper by Mr. Zeeman, on a new experiment concerning anomalous wave propagation. Gouy's theory of the subject (*Ann. de Chim. et de Phys.*, vi. 24) was confirmed by means of a combination of a lens and a plate of Iceland spar cut so as to have the optical axis in their planes. Transmitted light was used. The experiment has some advantages over one devised by Joubin for demonstrating Gouy's theory, the principal one being the possibility of having any value for the initial phase difference of the two interfering pencils in the central part of the field.—Prof. van der Waals also presented, on behalf of Prof. Kamerlingh Onnes, (*a*) a paper, by Mr. A. van Eldik, on measurements of the capillary ascent of the liquid phase of a mixture of two substances in equilibrium with the gaseous phase; (*b*) a paper, by Mr. L. H. Siertsema, on the influence of pressure upon the natural rotation of the plane of polarisation in solutions of cane sugar. The measurements mentioned on a previous occasion have been continued with a concentration of 27·84 gr. in 100 cc., and have yielded a variation of 0·270 per cent. for 100 atm. If Tammann's hypothesis concerning the equivalence of internal and external pressure is adopted, these results may be compared with those respecting the variation of the specific rotation capacity by a variation of concentration, or by the addition of an inactive salt. The comparison shows that the phenomenon is probably more complicated than Tammann's hypothesis renders it.—Prof. Lorentz presented, for publication in the *Proceedings*, a paper entitled "On the resistance which a liquid current meets with in a cylindrical tube."—Prof. Bakhuis Roozeboom presented, on behalf of Dr. E. Cohen, a paper on the inversion constant of sugar in an aqueous solution. This constant varies with the concentration of the sugar solution. This difference can be removed if, in calculating the concentration of the inverting acid, the total volume is not used, but if the volume of the sugar in the solution is deducted from it. In this way there arises perfect agreement with the theoretical process of the reaction, as Dr Cohen demonstrated with experiments made by Ostwald, and observations made by himself, with acids of $\frac{1}{8} - \frac{1}{128}$ norm.—Prof. J. C. Kapteyn contributed a communication on the distribution of stellar velocities, being a sequel to a former paper on the same subject (May 1895). The author shows how the *magnitude* of the proper motions may be made to contribute to the derivation of the law of velocities, as well as their *direction*. The author further shows that the most serious anomalies which remain in the distribution of the directions of the proper motions, even as computed with the best data available for the precession and the position of the apex, will disappear for by far the greater part, by assuming a constant error, or an error proportional to the cosine of the declination, in Auwers' proper motions in declinations.

BOOKS, PAMPHLET, and SERIALS RECEIVED

BOOKS.—Die Mechanik des Weltalbs: Dr. L. Zehnder (Freiburg i.B., Mohr).—Electricity and Magnetism for Beginners: F. W. Sanderson (Macmillan).—Hallucinations and Illusions: E. Parish (Scott).—Wild Flower Lyrics: J. Rigg (A. Gardner).—Electric Smelting and Refining: Dr. W. Borchers, translated, with additions, by W. G. McMillan (Griffin).—Lehrbuch der Erdkunde: Dr. W. Ule, 1 Teil (Leipzig, Freytag).—The Ancient Stone Implements, Weapons and Ornaments of Great Britain: Sir J. Evans, 2nd edition (Longmans).—Reform of Chemical and Physical Calculations: C. J. T. Hanssen (Spon).

PAMPHLET.—On the Synthesis and Molecular Constitution of Dead and Living Proteid: Dr. P. W. Latham (Cambridge, Deighton).

SERIALS.—Traité de Zoologie, Fasc. xi. and xvi. (Paris, Rueff).—Jahrbuch der K. K. Geologischen Reichsanstalt, 1896, 3 u. 4 Heft, and 1897, 1 Heft (Wien).—Mind, July (Williams).—American Journal of Science, July (Newhaven).—Journal of Anatomy and Physiology, July (Griffin).—Geological Magazine, July (Dulau).—Lean's Royal Navy List, July (Witherby).—Plantæ Europæ, Tomus ii. fasc. i. (Leipzig, Engelmann).—Brain, Parts 77 and 78 (Macmillan).

CONTENTS.

THURSDAY, JULY 22, 1897.

THE ELEMENTS OF PHYSICS.

The Elements of Physics. By Edward L. Nichols and William S. Franklin. Vol. i. Mechanics and Heat. Pp. x + 228. Vol. ii. Electricity and Magnetism. Pp. ix + 272. Vol. iii. Light and Sound. Pp. vii. + 201. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1896.)

THE title and contents of such a work as that before us open up many questions regarding physical theory and its presentment, on which every teacher must hold more or less strong views resulting from his training and experience. Hence, in reviewing it, the temptation to discuss particular points rather at length is almost too powerful to be resisted, and perhaps need not always be overcome. If then, in what follows, there is any noticeable tendency of this kind, it is not to be supposed that the pronouncement of the authors is necessarily objected to; but that some passage or other has suggested what may appear to be rather a digression.

The authors have endeavoured to give a short and clear account of the various quantities in the subjects of Mechanics, Heat, Electricity, Optics, and Acoustics, which are capable of exact measurement. Of course, within the limits of space assigned, a full theoretical discussion is impossible; but each concept is carefully explained, and an indication is given of how its numerical magnitude can be determined. The work is in our opinion a thoroughly sound and satisfactory introduction to the science of physical measurements.

Volume i. begins with a chapter on Length, Time, and Mass. It includes an account of such length-measuring instruments as the scale and vernier, cathetometer, dividing engine, and spherometer, and of instruments for weighing and the measurement of time. These discussions are merely in skeleton, and must be supplemented as regards both the theory and the use of the instruments by reference to more exhaustive special treatises.

With regard to the measurement of time, variation in the amplitude of vibration of a clock-pendulum ought, as the authors say, to be avoided as far as possible by making the gear and escapement of fine workmanship, and no sensible alteration of the rate of a clock ought to be allowed to arise from such a cause. Since, however, the word "pendulum," as used by the authors, appears to include the balance of a pocket chronometer or watch, it would have been well to point out here that, in such a case, large variations of amplitude with changes of position of the chronometer cannot be avoided, and to mention the interesting fact that practical equality of period is, in such circumstances, secured by carefully adjusting the balance-spring to the exact length for which the long and short vibrations are most nearly isochronous. We may refer, in connection with this very important subject, to a valuable, though apparently little known, memoir by M. Phillips in *Liouville's Journal*, Sér. ii., Tome v. (1860), in which the Breguet form of balance-spring, with its peculiarly curved over-coil, now generally adopted in compensated chronometers, is arrived at as a result of mathematical calculation.

The chapter on Physical Quantity contains a very short account of the Dimensions of Derived Units. The exact meaning and force of a dimensional equation are of great importance, and a page or two of additional space might with advantage have been devoted to this subject, at the expense, if need were, of the explanation of vector-products which comes immediately after, and which, so far as we have observed, is not called into active service subsequently in the book.

The authors rightly devote a little space to making clear exactly what is meant by the equality of action and reaction asserted in the third law of motion. It is curious that the most essential point is not more emphasised in elementary text-books of dynamics, namely, that the action and reaction, which are equal and opposite, and which act across the same cross-section of a wire or rod, or across the surface of contact of two links of a chain, and which the ordinary learner often thinks ought to cancel one another, are opposite forces *acting on different portions of matter*, and therefore do not annul one another, unless the rate of change of momentum of a system including both portions of matter is under consideration.

It is remarkable that the paradoxer who insists on making the mistake here indicated, and supports his views with so much nonsensical rigmarole, mixed up with wild talk about conspiracies of mathematicians to defend the views of Newton, never commits a similar error in financial matters! He does not consider the handing over of a sum of money by one person—himself, for example—as cancelled by its receipt by another person. Yet the two aspects of this transaction (like the forces which are the two aspects of a stress) are equal and opposite; but they affect different persons, and he sees clearly enough that one cannot be regarded as annulling the other, unless the question is as to the total sum of money possessed by the two persons concerned.

We may remark that it does not seem clearly brought out in connection with the experiments of Galilei, mentioned on p. 36, that what was proved by his famous experiments on bodies let fall from the top of the leaning tower of Pisa to the pavement beneath, and also by Newton's pendulum experiments, was the proportionality of the gravities of different bodies to their inertias. Hence the experiments show that when the masses of bodies are measured by their inertias, the results are equivalent to those obtained by the process of weighing.

In this chapter the authors call a velocity of one centimetre per second a "kin." There is undoubtedly an advantage in having names for the units of quantities which are apt to be confounded; but velocity and acceleration are both so fundamental conceptions as to make it imperative on the student to completely master their meaning and the manner in which they involve the fundamental units, if he wishes to make any progress at all; and we question if there is any real want of names for their units.

Equation (48) on p. 50, expresses a result in simple harmonic motion which is one of the few formulæ in

physics it is desirable to carry in the memory for instant use. It would be more portable if made explicitly kinematical by being reduced to the form

$$\frac{\text{acceleration}}{\text{displacement}} = \frac{4\pi^2}{T^2},$$

where, on the left, numerical values without regard to sign are understood. The introduction of the mass m of the vibrating particle, together with a quantity a, which is the product of m by the positive numerical value of the acceleration, seems an unnecessary complication.

The authors give in Chapter vi. an excellent elementary account of stress and strain. Everything is clearly and concisely stated, and a student seeking an accurate quantitative outline of the subject as a starting-point for a more complete study of experimental elasticity could hardly find anything more satisfactory.

We note in this chapter the use of the form "elotropy" for "eolotropy" (or, better, "æolotropy") to denote difference of elastic quality in different directions in a body. It seems hardly allowable to adopt this spelling in view of the derivation of the first part of the word from αἰόλος, meaning *quick-moving*, *changeful*, *variegated*.

It is of considerable experimental importance to point out that what the authors call the constant of torsion of a wire (that is, the torsional rigidity) is calculated on the assumption of perfect circularity of cross-section, and further involves the fourth power of the radius of the wire; so that it is hardly possible to draw from oscillation experiments exact conclusions as to the value of the rigidity-modulus of the material.

The definition of perfection of elasticity, on p. 102, seems hardly guarded enough. A body may, after the removal of stress, return to precisely its former configuration, so far as that can be tested at least, and yet be subject to imperfections of elasticity. Let the body be subjected to increasing stress, and let the successive configurations be noted; then let the stress be gradually altered back again to the former value, and the configurations in returning be again noted. If the configuration corresponding to a given value of the stress be the same during the removal of the stress as during its imposition, the body is perfectly elastic, but not otherwise. If the configurations and stresses be represented graphically, the curves for the transition from initial to final stress may not coincide with that for return from final to initial stress, and energy will be dissipated (in consequence of imperfection of elasticity), the amount of which can be estimated from the area enclosed between the two curves.

The next chapter (vii.) deals with Hydro-Mechanics, a subject the extent of which must have been very embarrassing to the authors, considering their plan, and the amount of space at their disposal. On the whole, they have given a fair account of leading principles, and especially of those of capillarity and viscosity; and we have in these all the merits of treatment that mark the rest of the work.

In the remarks in this chapter on the experimental verification of Boyle's law (Mariotte's or Boyle's law the authors call it !), there is no reference to what constitutes the real divergence of gases, such as nitrogen, oxygen and hydrogen, from fulfilment of this law. In fact, it is stated that for a gas the "loss of volume is greater than would be expected from Mariotte's law, the divergence from inverse proportionality increasing as we near the point of condensation." But, as no doubt the authors are fully aware, deviations from fulfilment of Boyle's law are not confined to gases which are in "an intermediate condition preparatory to liquefaction," but are found also in true gases—gases, that is to say, which are far above their critical temperatures. The researches of Regnault, and the later and much more extended investigations of Amagat, which have given us most complete and interesting information as to how far "true gases" conform to Boyle's law, are of great importance from the point of view of kinetic theory, and should surely have been noticed here.

The account given in Art. 192, p. 136, of efflux of liquid from an orifice in a vessel, seems to require amendment, which should also be extended to Art. 193. As a matter of fact, the pressures at the outside of the jet and at the free surface are practically the same, so that $p-p_1$, instead of being equal to xdg, is really zero. Also, though this is a small matter, it would seem better to use ρ than d to denote density; as expressions like dv^2, dg, are instinctively associated with other meanings than those intended.

Passing now to the part of the book which treats of Heat, we are glad to see so excellent an account of the subject of temperature. It is short, and seems to be correct; which is more than can be said of nine out of ten of the discussions in text-books on this very important subject. Of the fact that thermometers made with different kinds of glass, and graduated with absolute accuracy, will agree at the temperatures of reference, 0° C. and 100° C., and will agree nowhere else, the majority of text-book writers seem to be in blissful ignorance. Nothing is more confusing than the customary proceeding (much followed by a certain class of writers on thermodynamics !) of defining temperature on a mercury-in-glass thermometer, sometimes with ignoration of the expansion of the vessel, sometimes not; but always with the further erroneous statement that the increase of pressure of a gas kept at constant volume is the same for each degree of rise of temperature on this scale, a "fact" which is supposed to express the law of Gay-Lussac. It does not occur to such writers that, if Gay-Lussac's law were to thus hold for one thermometer, it could not hold for other thermometers made with different kinds of glass, and therefore having different scales. And, unhappily for those who define their scale of temperature with regard to the absolute expansion of mercury, with or without nonsense about mercury being "chosen on account of its uniform expansion," the divergence of the air-thermometer from such a standard is much greater than from a thermometer constructed with ordinary glass.

The vicious circle thus introduced into the definition of the standard scale of temperature, and the failure to regard the air-thermometer scale and the absolute thermodynamic scale of temperature as each derived from its own independent definition, is responsible for much of the prevalent haziness in the application of the fundamental principles of heat and thermodynamics.

These mistakes are avoided in the book before us; but we cannot help thinking that the part of the book which deals with thermodynamics would have been improved by a somewhat different order of treatment. The first real step in thermodynamics should always be a discussion of Carnot's heat-engine and Thomson's definition of absolute temperature. Then, all about the behaviour of gases, and the deviation of temperature as defined on the air-thermometer from absolute thermodynamic temperature, could have been told, we think, much more effectively. As it is, Joule and Thomson's experiments, which we are informed were made for the purpose of deciding whether there is any sensible attraction between the particles of a gas, are mentioned only once in the book, and that long before the scale of absolute temperature is referred to. The most important part of the significance of this investigation is really lost unless its bearing on the realisation of absolute temperature is fully pointed out. We may have unduly emphasised this omission; but we are sorry a book, so generally good as this is, should have in any degree missed an opportunity of insisting on absolute temperature and all that thereto relates, as the first and fundamental thing, we had almost said the only thing, in thermodynamics.

The second and third volumes of Messrs. Nichols and Franklin's book, which deals with Magnetism and Electricity, we have but little space left to deal with. But we may say at the outset that, good as the first volume seems to us to be, these seem quite up to the same level.

In vol. ii. a short and satisfactory account of Galvanometry is given under the heading of Electrolysis and Batteries. The laws of electrolysis are stated, and some space is devoted to a discussion of the Energy Theory of the Voltaic Cell, though not more than or even quite as much as the importance of the subject deserves. In the sketch of the thermodynamics of the voltaic cell the phrase, "sweeping processes performed by the current," strikes one as quaint, to say the least. The "sweeping process" is not performed by the current at all, but by Messrs. Nichols and Franklin when they draw an indicator diagram to represent a certain part of the work done by the current.

The book is brought up to date by an account of the kathode discharge within a Crookes' tube, and of Röntgen's discovery. This chapter contains, besides, a very brief account of the discoveries of Hertz.

Practical Applications are dealt with in a chapter mainly devoted to Electric Signalling. The usual telegraphic devices are described; but none of the vexed questions on this subject are gone into. The authors, however, do say that the so-called KR law holds for telephonic signalling as well as for submarine telegraphy, which is, to say the least, a rather inadequate statement.

A chapter on Mechanical Conceptions of Electricity and Magnetism completes the second volume. The idea adopted is that the ether in a magnetic field has a cellular structure, and that these cells have a rotational motion about axes parallel to the direction of the field at each point, while the lines of electric force are marked by displacement of these ether-cells—the positive in one direction, the negative in the opposite. There are, of course, serious difficulties in this mode of regarding what takes place; so much so, that there seems now rather a consensus of opinion in favour of the view that the direction of magnetic force is that of flow of the ether regarded as a perfect fluid. Such questions, however, the authors, probably from want of space, do not discuss.

Volume iii. begins with a statement of the distinction between light and sound as cases of wave-motion, and a comparison of the methods of determining their velocities of propagation. Then follows an account of wave-motion with the usual theorems on composition of vibrations, constructions for wave-fronts of reflected and refracted waves, Huyghens' zones, &c. The succeeding chapters deal with the theory of mirrors and lenses, treated, as they always ought to be in a physical book, by means of considerations of wave-propagation and the principle of equal optical distances. The old rule, convenient for use in the approximate fashioning of glass lenses, might have been noticed at p. 47, that the radius of the opening of a convex lens is nearly (for index of refraction 1·5) a mean proportional between the focal length of the lens and its thickness.

The chapter on Dispersion (prismatic) strikes us as capable of considerable expansion. The conditions for obtaining a pure spectrum do not seem to be stated, except in so far as they are given more or less implicitly in connection with the spectroscope. In preparation for this an elementary account of primary and secondary focal lines might be added to the chapter on lenses, and the reason for placing the prisms of a spectroscope in the position for minimum deviation explicitly brought out.

The account of double refraction we find unexpectedly short. Refraction in uniaxal crystals is alone treated, Huyghens' construction is given for the single case of Iceland-spar, and there is no notice of the other typical case, that of quartz.

But the most serious omission in this volume, perhaps in the book, is that of any adequate discussion of magneto-optic rotation. Article 754 is devoted to "Rotation of the plane of polarization; the saccharimeter," and Art. 755 (rather more than half a page) deals with magneto-optic rotation. The latter subject is not discussed in vol. ii., and we had expected to find in vol. iii. an account of phenomena, of the very important absolute determinations of Verdet's and other constants that have been made, and of the applications of the knowledge so obtained in magnetic research. As it is, six lines are given to rotation of the plane of polarised light in bisulphide of carbon, and the remainder to a photo-chronograph, which, though ingenious and valuable, hardly in the circumstances should have had so relatively large a part of the available space devoted to it.

In our account of this work we have referred to a number of points in which, as it appears to us, it could be improved and amplified without seriously adding to its bulk. The number of such points may seem rather large, but in this it is like every other treatise on its first appearance; and we hope that the authors will believe that the statements above are not made in any carping spirit, but rather as marking appreciation of what is, within its scope and purpose, really an excellent work.

A. GRAY.

THE IRISH DOLMENS.

The Dolmens of Ireland; their Distribution, Structural Characteristics, and Affinities. By William Copeland Borlase, M.A. 3 vols. Pp. xxxvi + 1234. (London: Chapman and Hall, Ltd., 1897.)

THIS work is divided into four parts: a descriptive topographical catalogue of the Irish dolmens; a discussion of the classification and distribution of dolmens in general; a collection of the popular lore relating to the Irish examples; and an ethnological investigation of the subject.

Until the long-desired official survey of British archæology is carried out, we can hardly look for the compilation of a perfect list of dolmens or of any other remains of the kind. At present a student has to be content with the Ordnance maps—from the archæological point of view most unsatisfactory documents—and with the often inadequate and unscientific writings of previous workers. Mr. Borlase has made the best possible use of this imperfect apparatus; but the Ordnance maps have misled him into including an uninteresting microlithic cairn at Baltinglass among the Wicklow dolmens, and into omitting an example at Donard in the same district: while it is something of a disgrace to Irish archæologists that for an account of the very remarkable structures at Breastagh and Rathfran, in Mayo, he has had to depend on Cæsar Otway's worthless gossip. Notwithstanding these and similar more or less unavoidable inaccuracies, the first part of this book is a useful contribution to archæological literature; indeed, it is almost a pity that Mr. Borlase did not content himself with publishing Parts i. and iii. together, omitting the speculative portions of the book, which overload it and are sufficiently independent of its subject to form a separate work. Four excellent maps show the distribution of the recorded dolmens in each of the provinces of Ireland; but their value would have been enhanced by the use of different marks to distinguish dolmens of different types from each other and from chambered tumuli.

The second part consists of a conspectus of the dolmens of Europe and Asia, resembling the well-known bird's-eye view in Fergusson's "Rude Stone Monuments," but much more full and up to date. It reveals, however, how much has still to be done in elementary field-work on the prehistoric remains of the continent.

Part iii. is of considerable value. It consists of a careful classification of the names attached to various Irish monuments and the popular lore concerning them. Here Mr. Borlase has made full use of the Ordnance Survey Letters, now so long left unpublished by the deplorable parsimony of the wealthiest of Governments. Not the least valuable part of the work consists in the long extracts from these MSS., here for the first time edited. It is not, however, to be expected that all Mr. Borlase's statements will command acceptance. His view, somewhat obscurely set forth[1] on p. 758, that a reference to *cats* in the name of a monument has no connection with the animal, but means that the object has a hole in it (*cuthe*, a pit), is negatived by one of his own examples—Kit's Coty House, which has no such hole, except one left by the natural irregularity of the central stone: nor is there any hole in the ring-fort known as *Cathair na gcat* at Ballywiheen, in Kerry. It is not necessary, as the author does (p. 769), to make a pagan word of *leaba* "a bed" (in the sense of "grave"); on Aran we have *Leaba Brecain*, *Leaba na seacht naomh*, and the strangely named *Leaba an Spioraid Naoimh*. On p. 842 the author repeats one of the most extraordinary blunders made in recent anthropological research—the assignment of a high index of nigrescence to the west of Connacht and Kerry.

[1] A fault not confined to this one passage: the book is sometimes difficult to follow from the imperfection of the English style, and the frequency and length of the digressions. On pp. 1056–7 is one portentous sentence, unbroken by any stop heavier than a comma or dash, thirty-four lines long!

Ireland is no exception to the rule that the antiquities of a country cannot be properly investigated without a preliminary study of its language. An experience narrated on p. 846, shows that Mr. Borlase has not gone through this desirable preparation. For two reasons this is regrettable: popular lore would be much more accessible to him; and some of his amazing blunders in writing Irish names and words would have been impossible. Such a sentence as the following—supposed to be addressed to a child—could not have been passed without a feeling of discomfort—

> Eist a laogh (!) agus cuiramag (!!) diotal (!) air an Garran (!) ban (!) dhuil (!!)[1]

The eccentricities of this sentence exemplify what is a very serious fault throughout this book—its typographical inaccuracy, which is little short of disgraceful to printer, publisher and author. Mr. Borlase speaks in his preface of the "desperate monotony" of proof-reading: but this monotony is the common lot of all authors, and affords no excuse for "Sir S. Fergus*s*on," "O'Curr*ie*," "Hissar*l*ik," "paals*l*ab" (four times, pp. 675–80), "poletax" (p. 1090), "culminator" (for calumniator, p. 1046), &c.

In the fourth part of the book the author discusses at considerable length the physical features of the inhabitants of different districts in Ireland, with reference to the characteristics of other races. He begins with the skulls, comparing them with all European varieties, from the Neanderthal downwards. On the whole this part of the work is unsatisfactory; it is inaccurate in some places, out of date in others; and most of the pictures of skulls are very bad. For instance, it is a pity that the author speaks (pp. 979 *sqq*) of Irish "long-barrow" skulls; for no such thing has hitherto been described. Both the Trillick and Tily Hole specimens have been posthumously deformed, and they are thus more than doubtful analogues of the English long-barrow type. The Aylesbury Road mound, on which Mr. Borlase lays much stress, is an equally unfortunate example; for, in the first place, Prof. Macalister, of Cambridge, who exhumed many and examined all of the remains there found, is positive that "no one familiar with the long-barrow race could ever confound a single skull from this heap with the long-barrow type of skull"; and, in the second, it is questionable whether the Aylesbury Road massacre, which has been so luridly depicted for us, is a historical event at all, for there is no reason for regarding the mound as anything less prosaic than a mediæval plague-

[1] It ought of course to be something like this—*Eist a laoigh, agus cuirfead diallaid air* (better *ar*) *an ngarrán bhán duit*, "Hush, calfie, and I'll put a saddle on the white nag" (not white *mare*, as Mr. Borlase renders it) "for you."

pit. It is curious that Mr. Borlase calls the Armoy skull (p. 993) dolichocephalic with an index of 0·77; the limit of dolichocephaly usually adopted is 0·75.

After touching on nigrescence and other physical features, Mr. Borlase concludes his work with a dissertation on the Invasion Saga-group of the Irish manuscript romances. It will be observed that he has practically left the dolmens: but his thesis is that the dolmens and all the other tangible remains of prehistoric Ireland have nothing to do with the extant legends. With singular ingenuity Mr. Borlase develops a two-fold theory about these writings: first, that they are a barbaric version of the historical *Volkswänderung;* and, secondly, that they are native to the south coast of the Baltic, being only Irish in the sense of having become naturalised there. Conaing's tower on Tory Island is razed, to be rebuilt on Rügen; and all the other sites and scenes are transported in a manner equally calculated to disturb the repose of the honoured ghosts of Keating and the Four Masters. Clearly this novel theory leaves all Irish remains unaccounted for by divorcing from them the legends which, in some measure, fit them with tolerable accuracy; and transfers the legends to a soil where there are neither tangible remains, nor local folklore, with which they can be compared. It would be easy to pick holes in some of Mr. Borlase's etymologies, such as the suggested connection between Partholan and the Lombards, which reminded us of nothing so much as the schoolboy's correlation of eel-pie with a pigeon: but space forbids our saying more than that we do not believe the last word has yet been said on the mystery of the Irish romances.

We have read these three handsome volumes with interest and pleasure, not unmixed with regret that a little more judicious pruning was not employed in both letterpress and illustrations. Many of the pictures of dolmens might as well have been omitted, since in the absence of plans they are useless.[1] The money thus saved would profitably have been expended in improving the quality of the remaining cuts, and in remunerating a competent proof-reader.

One more complaint in conclusion. Why does Mr. Borlase—a scientific archæologist—speak of the Clonmel tragedy of two years ago as a witch-burning case?

R. A. STEWART MACALISTER.

[1] A perspective sketch, or photograph, of any structure is of little or no (generally no) value without a plan. We trust that all promoters of photographic surveys realise this.

HUMAN EMBRYOLOGY.

Human Embryology. By Ch. S. Minot, Professor of Histology and Human Embryology, Harvard Medical School, Boston. Pp. xxiii + 815. Large 8vo. (New York, 1892. English edition: Macmillan and Co., Ltd., 1897.)

IT is now five years since the publication of this work in America, but it is not to be supposed that because the science with which it deals has all the while been making rapid progress, it is on that account to be regarded as already out of date. For the nature of the book is of such a character as to constitute it a permanent work of reference in the subject; in which respect, although not in its scope and intention, it resembles closely the comparative embryology of Francis Balfour.

This is not the place to enter into a discussion of any of the immense mass of details which Prof. Minot has accumulated in his work, which he himself confesses to have occupied ten years of his life, nor would the space at my disposal enable me to do so, except in a most inadequate manner. Suffice it to say that there is no part of the subject which is not treated by the author in the most complete manner possible within the limits of a text-book. Beginning with an account of the structure of the uterus in its varying functional conditions, the history of the sexual elements, and a discussion of theories of sex and heredity, the author attacks the main subject of the work by an account of the segmentation of the ovum and the formation of the germ layers. The formation and destination of the primitive embryonic organs, the origin of the blood and blood-vessels, of the urogenital system, and of the archenteron are next treated of, and then follows a most important section of the work, in which the human embryo is dealt with as a whole, and followed through all its known stages. Accompanying this account is a complete and original description of the appendages of the ovum and their relation to the uterine wall. Finally the development of each tissue and organ is separately dealt with; and not only the changes of form, but the histogenesis of the organs also—a subject often left untouched in text-books of embryology—are considered in abundant detail. Each chapter—almost each page—is a mine of information, so that the book will be an essential companion of every one who may be working at vertebrate embryology. For although the author has not departed more than was possible from the scope of his work as indicated by its title, there is so much that is common in the development of all vertebrates that much of our knowledge of human embryology is primarily founded on facts observed in other mammals, and even in lower vertebrates, and reference must necessarily be constantly made to these.

The subject is so big, that it is obviously impossible for any one during a much longer period than ten years, and even if he should be in possession of the needful material, to attempt to give any account of it which shall be based upon his own investigations. Short of this, however, he may in many cases verify the statements of others; and when this does not prove possible, he may at least subject them to so critical an examination as to lend an additional value to them by reason of the stamp of his criticisms. These two processes Prof. Minot has very fully carried out in each subject which he has dealt with; and when to this statement it is added that some parts of the subject are based wholly upon the author's investigations, it will be seen that, exactly as with Balfour's book above referred to, there is a colour of originality pervading the whole work, which greatly tends to enhance its value.

Prof. Minot obtained his training in embryology and in the allied biological sciences mainly in German schools, and he is naturally thoroughly imbued with German methods of expression. This does not, however, in my opinion, justify him in bodily transferring German terms into the text of an English book without any attempt to furnish either an English equivalent, or an

equivalent easily coined according to the convenient and acknowledged methods of scientific word-making from the Greek or Latin. One gets accustomed to such a word as Anlage, which is in constant use throughout the book, and after a time begins to forget that it ever was anything but pure English; but I confess to being still somewhat staggered whenever I come across such phrases as that leucocytes "are transformed into *Bildungsgewebszellen*," that certain fibres are "situated in the Randschlier of the dorsal zone of His," and, only two lines further, that "the Rautenlippe during the fifth week buries the solitary tract." Prof. Minot belongs to a University which justly boasts having produced writers of as good and as pure English as can be met with anywhere, and he has himself a clear and trenchant style. It seems a pity, therefore, that he should not have stuck to his own language, or, as an alternative, he might have written his book wholly in German. It is no doubt sometimes difficult to get a good short equivalent of some German expressions, which include the meaning of a whole sentence in a single word; but the same difficulty has been met and combated successfully by other writers; and even if one has to resort to a phrase of two or three words to express in English the idea which one compound German word will imply, it is better, it seems to me, to adopt this plan than to intercalate into an English sentence foreign words, which can only be properly understood by those who are very familiar with the tongue they are written in. Your French scientific writers are never guilty of this fault—they have too much respect for their own language; but the practice is not an uncommon one with English and American scientific men, and ought, in my opinion, to be resorted to either not at all or only on the rarest possible occasions.

This is, however, a very minor fault, and one which in no way affects the scientific value of the book. And it is no exaggeration to say, in spite of the modest manner in which the author introduces his treatise to the public in the preface, that the work before us constitutes a monument of erudition in the difficult and complex subject of which it treats. E. A. SCHÄFER.

OUR BOOK SHELF.

Catalogus Mammalium tam viventium quam fossilium. A Doctore E. L. Trouessart, Parisiis. Nova Editio (Prima completa). Fasciculus I. Primates, Prosimiæ, Chiroptera, Insectivora. Fasciculus II. Carnivora, Pinnipedia, Rodentia I. 8vo. (Berolini: R. Friedländer und Sohn, 1897.)

A NEW catalogue of Mammals is much wanted, and will be of great use to the many workers in that group of animals. This important branch of the Vertebrata appears to have been rather neglected by the authorities at the British Museum, who have recently issued many excellent volumes on the Birds, Reptiles, Batrachians and Fishes in the National Collection, but have done little work on the recent Mammals, although they have catalogued the fossil members of the group. We are glad, therefore, that Dr. Trouessart has taken up the subject, although he merely gives us a systematic list of names and localities, without any descriptions. Two parts of his "Catalogus Mammalium" are already issued. The first contains the Primates, Prosimiæ, Chiroptera and Insectivora; and the second, the Carnivora, Pinnipedia and the first portion of the Rodentia (Protrogomorpha and Sciuromorpha). We presume that a third part will finish the work. Up to the end of the second part, Dr. Trouessart, who includes both recent and external forms, has catalogued 1294 species. Of each of these the principal references and synonyms are given, and a short list of localities. We venture to think that it would have been better if the names of the recent and fossil species had been a little more clearly distinguished in the type. The fossil mammals are only recognisable in the present work by the "dagger" placed before the name, which may be easily overlooked. In most respects, however, the work appears to have been performed in a satisfactory manner, though it would not be difficult to point out a certain number of slips and errors. We have, nevertheless, no doubt that the volume when complete will be of much use for reference, and will supply a quantity of much needed information.

Essais sur la philosophie des Sciences Analyse-mécanique. Par C. de Freycinet, de l'Institut. (Paris: Gauthier-Villars, 1896.)

TREATISES of this nature are popular in France, to cite only the "Réflexions sur la Métaphysique du Calcul Infinitésimal" of Carnot, and the "Méthodes dans les Sciences de Raisonnement" of Duhamel; the only English equivalent would be Jevons's "Principles of Science."

M. de Freycinet has employed the leisure of the arduous duties of a Minister of War, in writing these essays, in which a philosophical view is taken of various sciences, treated in ordinary language, and addressed to cultivated minds. In the deep concentration now required in the specialisation of science, books such as this will prove very valuable to give the worker, too much absorbed in his own subject, a general perspective glance of what others are doing, devoid of all repulsive technicalities. We find on p. 158: "Il ne suffit pas d'avoir la notion claire de la masse. Il fait aller plus loin. Pour les besoins de la Dynamique il est nécessaire de *Savoir* chiffrer les masses;" . . . and again on p. 162, "Une quantité d'eau peu inférieure a 10 décimètres cubes, soit 9 litres 8088 . . .; le nombre habituellement désigné par la lettre *g*; voila l'unité de masse."

This will please Prof. Perry; and it is the definition of Euler, Lagrange, Laplace, Poisson, &c.; but, as a recent discussion has shown, the definition is considered heretical in certain educational quarters.

The Metric System is not absolutely sacred, even to a former Minister of France. M. de Freycinet brings forward, on p. 186, his proposal to shorten the metre, or rather to make *g* at Paris the unit of length, the sexagesimal second being the unit of time; while others would make the seconds pendulum at Paris the unit of length. G.

Wild Flowers of Scotland. By J. H. Crawford, F.L.S. Pp. 228. (London: John Macqueen, 1897.)

A NUMBER of people object to an abrupt introduction to nature; they prefer to flit around her like a butterfly around a flower, merely to take a casual glance at different aspects. To confront people of this temperament with a bare fact would be to destroy the interest—aimless though it be—they have in science. Wherefore such books as the one before us are written—books in which pretty things and picturesque scenes are viewed "in contemplative fashion" and poetic state of mind. The present work is not without a value; for it certainly teaches something about a few of the wild flowers of Scotland, but we fancy it will be read more for its easy style of composition than for the facts it contains.

The Science of Speech. By Prof. Alexander Melville Bell. Pp. 56. (Washington, D.C.: The Volta Bureau, 1897.)

THE purpose of the author of this work is to define the actions of the mouth and the vocal organs in the production of speech, and express them by a species of

phonetic nomenclature. Thirty-six vowel sounds are developed by labial modifications of sounds produced with definite positions of the tongue and certain size of the cavity of the mouth. The cause of the differences between vowels and consonants is explained, and the mechanism of distinct utterance is expounded. Teachers of languages and elocution may find the book of service for instructing their pupils how to arrange the tongue and lips in order to speak with correct accent.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Bipedal Locomotion among Existing Reptiles.

I COMMUNICATED to NATURE of February 27, 1896, and elsewhere, details with accompanying figures concerning the bipedal locomotion of the North Australian Frilled Lizard *Chlamydosaurus Kingi*, and which, with reference to such method of progression, apparently occupied a unique position among existing reptilia. As the result of a more recent investigation, I have discovered that a corresponding bipedal gait is assumed under favourable conditions—*i.e.* when running across a wide expanse of smooth and level ground—by the handsome Australian water lizard, *Physignathus Lesseuri*, such method of progress being most conspicuously manifested by the young and slender individuals. I have also ascertained that a similar mode of locomotion is adopted under like conditions by *Amphibolurus muricatus*, and I am inclined to anticipate that it will be found to obtain among many other of the Australian, and possibly African, Agamoid lizards that share with the foregoing species a relatively excessive development of the hinder limbs.

A like bipedal formula of locomotion has been hinted at, though not yet demonstrated, in the case of the Mexican Iguanoid, *Corythophanes Hernandesyi*, and will possibly be found to be shared by many allied members of the same family that present in common with it a corresponding superficial structural parallelism with the typical Australian Agamidæ. The discovery here recorded is submitted with the main object of indicating that the bipedal locomotion of Chlamydosaurus can no longer be regarded as a mere specific idiosyncrasy. The fact of its being shared by other widely differing members of the same Agamoid group, together with the circumstance of, as in the case of Physignathus, its being most prominently manifested in young individuals, would appear to indicate that the habit has been inherited from a race that possessed yet more essentially bipedal progressing proclivities. Reserving fuller details for a future communication.

W. SAVILLE-KENT.

Wallington, Surrey, July 18.

Sensitiveness of the Retina to X-Rays.

IS it not possible that the persistence of an image on the retina is due to phosphorescence? This would at once explain the sensitiveness of the retina to X-rays.

The curious phenomenon of the image moving in the opposite direction, observed by Mr. Harrison (p. 248), is no doubt due to the rays passing through the lens without being refracted; the effect of the image becoming larger, is also the result of the same cause. All objects to become visible must, therefore, be smaller than the retina.

ERNEST BRAUN.

42 Henslowe Road, East Dulwich.

Sample-Post for Natural History Specimens.

IN the issue of NATURE for June 17 (p. 159) it is stated that, at the recent Postal Congress held at Washington, it was decided that natural history specimens, not sent for commercial purposes, were to be permitted to pass by Sample Post between the countries of the Postal Union.

Permit me to mention that I have been informed by the Secretary to the Post Office, that the Convention giving effect to that decision does not come into operation until January 1, 1899.

WALTER F. H. BLANDFORD.

July 15.

AUSTRALIAN NATURAL HISTORY.[1]

WHETHER designed or accidental, it is a fortunate circumstance that this sumptuous volume—a real *édition de luxe*—makes its appearance at a time when the most remote portions of the British Empire are being brought into closer connection with the mother country. At such a time everything that tends to promote a more intimate knowledge of the natural products of our colonial dependencies deserves a hearty welcome at the hands of all interested in the expansion and unification of the greatest empire the world has ever seen. On these grounds, to say nothing of others, Mr. Saville-Kent and his enterprising publishers are to be congratulated on the appearance of the work before us. As an attractive volume for the drawing-room table, it would be hard to equal anywhere; the beauty of its illustrations, whether in the form of coloured plates or of collotypes, being above praise, and calculated to arrest the attention of many of those who have hitherto cared little or nothing for the products of tropical and subtropical nature. Indeed, the two chromos of coral-reefs at low water, one of which forms the frontispiece, while the other illustrates the chapter on Houtman's Abrolhos, may well make every reader long for the opportunity of beholding scenes of such transcendent loveliness.

For the production of such a work the author is fortunately gifted with endowments denied to many of his fellow naturalists, for, as we learn from the legends to the chromos, he is not only an accomplished artist with the brush and pencil, but diligent practice has made him no less successful with the camera. And as a consequence of this, one of the striking features of the work is a series of life-like portraits of many Australian animals in attitudes as unlike those given in ordinary natural history books as it is possible to conceive; the one being nature, while the others are but too often death caricatured. What, for instance, can be better than the picture of Spinous Lizards with the curious expansions on the neck on p. 84, reproduced on the next page, by the courtesy of the publishers? (Fig. 1). It is, however, not only with animate nature that Mr. Kent has been successful, his views of scenery, especially where the wonderful termite mounds are concerned, being admirable works of art, interesting alike to the lover of strange landscapes and to the naturalist.

As may be gathered from his preface, the design of the author was not to produce a systematic work on the fauna and flora of Australia—of which we have plenty—but "to present to the English reading public a few glimpses" of its natural products, with special attention to the habits of some of the more interesting animals. In this laudable object he has, on the whole, succeeded admirably; and although his primary object has not been to attract the professed naturalist, many of his observations—notably those on the use of the leg-spur of the Duckbill—are of the highest importance to all students of natural history.

Not that Mr. Kent treats many parts of his subjects in a superficial, or even what may be termed a purely popular manner. We have, for example, in the introductory chapter a long dissertation on the relation of Australasia to other countries of the southern hemisphere, which may possibly be above the heads of some of his readers. In this we note that he adopts the view that Australasia, Africa, and South America have been in mutual connection at no very remote epoch; but in giving his adhesion to the theory that such connection took place solely by means of an Antarctic continent completely cut off from more northern lands, he has evidently not studied some of the more recent literature on this fascinating but difficult subject. And we should

1 "The Naturalist in Australia." By W. Saville-Kent. 4to. Pp. xv + 302. (London: Chapman and Hall, Ltd., 1897.)

much like to know how he reconciles this assumed southern origin of the marsupial fauna with the occurrence of opossums in the European Oligocene. He is also not quite up to date with regard to the extent or affinities of some of the groups of the southern fauna. For instance, on p. 4, we find no mention of the fact that *Galaxias* is represented at the Cape; while, from a statement two pages later, the author appears to be unaware that the giant extinct birds of Patagonia have no sort of relationship with the Ostrich group. Then, again, we must take exception to the statement on p. 15, that the Australian fauna comprises only "a few rodents"; while we should like to be informed whether, in face of the views of Mr. Douglas Ogilby, he has any special reason for the statement that "there is strong reason to believe" the Dingo "was introduced by human agency." Although it is perhaps invidious to call attention to slight slips in a work of this nature, it is difficult to avoid asking why Señor Ameghino is credited on p. 20 with writing in the "Brazilian" *Bulletin of the Academy of Cordova;* to which it may be added that the voluminous writer referred to has had a good deal to say on the same subject since 1894.

After treating in the introductory chapter of the leading types of Australian mammals, some of which are admirably illustrated, and a few of the birds, in the second chapter the author describes in detail the manners and appearance of some of the more notable species among the latter. And here his photographs of the "More-pork" (*Podargus*) and "Laughing-jackass" (*Dacelo*) are almost speaking likenesses. Something, however, might well have been added with regard to that very characteristic Australian bird, the Piping-crow (*Gymnorhina*), which appears to be only incidentally mentioned on p. 52. Following birds, the third chapter is naturally devoted to lizards, where the author's illustrations of the extraordinary attitudes assumed by the frilled lizard (*Chlamydosaurus*), previously published in the Zoological Society's *Proceedings* and in NATURE, are reproduced. Although it is less apparent than before, it is to be regretted that the author cannot thoroughly purge himself of the idea that the erect attitude of this creature has something to do with Dinosaurian ancestry; and it would have been much better if all reference to the structure of *Compsognathus*, about which the general public knows nothing and cares less, had been omitted. After lizards we look in vain for snakes, and we should have expected fishes in juxtaposition. These latter are, however, treated of in the sixth chapter, where Mr. Kent, with twelve years' experience as inspector of fisheries in "Westralia," speaks with authority. We are here introduced to a number of piscine types unfamiliar to the European, some remarkable for their size and peculiar structure, while others, like the Coral-fishes, to which a coloured plate is devoted, claim attention from their brilliant hues and grotesque forms. It is, however, by no means the largest or the best-flavoured fish that are of the most commercial value. "From a utilitarian point of view," writes the author, "the Barracouta (*Thyrsites*) is undoubtedly one of the, if not the, most important of the Tasmanian food-fishes. While the real or Hobart Trumpeter may be said to typify the species fitted, like the Turbot, to grace the table of the wealthy, the Barracouta may be as essentially styled the poor man's fish. It takes in Tasmania the place that is occupied by the modest Herring or the Haddock in the English market."

Turning back to chapter iv., we find this devoted to White Ants, or Termites, and the marvellous size and form to which they raise their mounds in certain parts of the country. Indeed, so numerous and so large are these mounds, that they frequently form an important feature in the landscape, as is well shown in several of the illustrations, one of which we are able to give (Fig. 2).

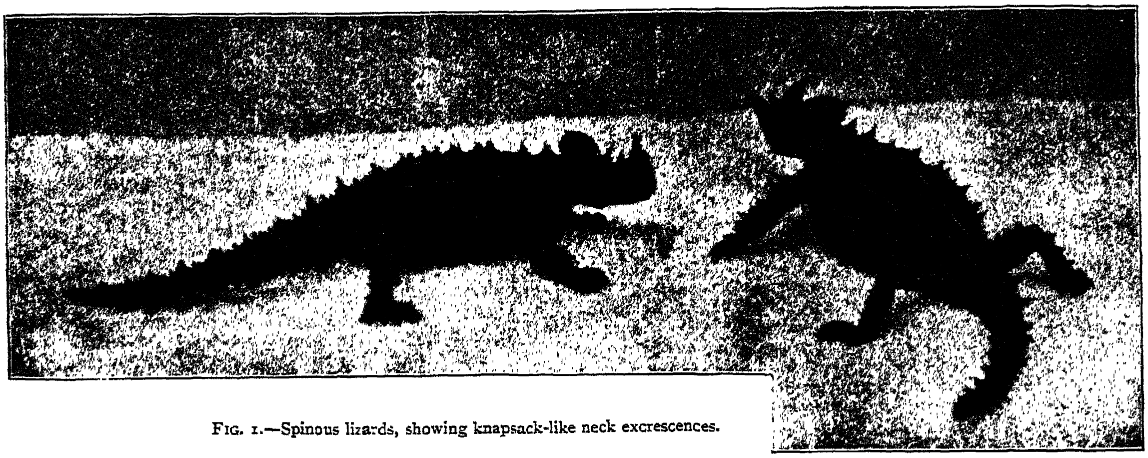


FIG. 1.—Spinous lizards, showing knapsack-like neck excrescences.

Perhaps the most fascinating chapter in the book is the one (v.) describing Houtman's Abrolhos, those low-lying coral islands situated off Western Australia, so interesting to the historian as being the scene of the wreck of the Batavian expedition of 1629, which led to the discovery of Australia, and to the naturalist as forming the border line between a tropical and temperate fauna. Nowhere else, we are told, are such extensive sheets of one and the same species of coral to be met with as here. Of the reef corals, the author writes that "while growing very near to the surface level of the water at low ebb tide, they very rarely appear above it, and then to the extent of a few inches only." And it is well for them that this is so, since the author relates how on one cold winter morning he found the tips of the madrepores that had been thus exposed, completely killed, indicating, in spite of their luxuriant growth, that we are near the limits suitable for coral existence. Much interest attaches to the author's description and illustration of "the birth of a coral island," but for this and the description of the coral reefs themselves, we must refer our readers to the original. Pearls and pearl-fishing, although intimately connected with coral reefs, are treated of in chapter vii. in a manner adequate to the importance of such a valuable trade; and the reader will there learn how the fishery has been gradually driven by exhaustion from the shallows to deeper and deeper water, while the complexity of the plant required for its

successful prosecution has concomitantly increased. To replenish the waste, artificial cultivation of the pearl-oyster has been tried in various localities; and of all these, the author considers that the islands of Torres Straits are the most likely to yield successful results.

The last three chapters, respectively entitled "Marine Miscellanea," "Insect Oddities," and "Vegetable Vagaries," we are reluctantly compelled to pass by without mention, although all merit the reader's best attention. Were our notice extended to three times its length, even then but comparatively few of the more interesting points in this volume could be touched upon; but as it is, enough has been said to indicate how well the author has made use of his exceptional opportunites of observation, and in what an attractive guise he has presented his results to the public.

R. L.

FIG. 2.—Termite mounds, Albany, North Queensland.

THE CALCUTTA EARTHQUAKE.

ON Saturday, June 12, at almost precisely five o'clock in the afternoon, Calcutta was visited by a somewhat severe shock of earthquake, most sensational reports of which, judging from the accounts that have appeared in the Indian papers, were probably telegraphed to England, and must have caused considerable anxiety among those who have relatives or friends out here. As a matter of fact few lives were lost, the warning given by the preliminary tremors allowing every one ample time to escape from their tottering dwellings, while in the crowded native quarters of the city the damage done is remarkably slight, the European quarter having suffered most. This apparent partiality of the shock is not, I think, to be attributed to any difference in its severity over the two areas, but rather to differences of construction and environment of the buildings. In the native town the houses are, as a rule, low, and built close together, thus supporting each other, while the European houses are generally detached, each standing in its own compound, and very commonly three stories in height. It is a notable fact that the only buildings greatly damaged are old, mostly dating back to the beginning of the century, or even older, and that they have already been subjected to severe shocks of earthquake, and were badly cracked. No new buildings have suffered in anything like the same degree, and it is difficult to find a crack anywhere that one can safely assume to have been caused in the first instance by the present earthquake. The common practice of the owners, after such a visitation, is to have the cracks covered up by a thick coating of plaster, so that to all appearance a house is as sound as before. In many cases this practice is being followed out now, so that there is every prospect of the next earthquake being attended with still more disastrous results.

In addition to the faulty construction of the buildings just mentioned, the damage caused must be attributed to the duration of the earthquake, rather than to any inherent severity of the shock itself. Various estimates are given as to the duration of the shock, ranging from four to ten minutes, and it must have lasted at least six minutes. The most trustworthy observations give 16h. 58m. (local time) as the time of commencement, while two of the observatory clocks at Adipur stopped, within a few seconds of each other, at 17h. 4m. 22s. and 17h. 4m. 26s. respectively. The buildings had thus ample time to take up the impulses given to them by the vibration of the soil, and after the earthquake had continued for a couple of minutes or so, each building was rocking to and fro with its own particular period of vibration, irrespective of the period of vibration of the earth, which I do not think varied much during the time it lasted. I happened to be on the third story of a new building, which was not damaged, at the time of the earthquake, and it seemed to me (and my observation has been confirmed by others to whom I have spoken on the subject) that distinct nodes were perceptible, during which, presumably, the vibrations of the house and those of the earth interfered with each other; and it is to the twisting effect produced by the presence of these nodes that I would attribute most of the damage done. It is curious that not a single factory chimney was overturned, or even cracked, though the chimneys rocked violently from side to side; their rate of vibration probably synchronised more or less with that of the earth. On the other hand, three, at least, of the church spires have broken off near the top; but in

their case the vibrations were probably more complicated than in the chimneys, through their being attached to the body of the church in each case, and also owing to their conical shape.

Falls of isolated objects, unconnected with any building, from which the direction of the shock might be ascertained, are exceedingly rare. Only two of the monuments in the old cemetery were affected, but both of these give the same direction, viz. approximately N. 30° E., S. 30° W., the fall being in each case towards the S.W. One of these monuments is an obelisk over the tomb of Sir William Jones, the founder of the Asiatic Society of Bengal. The building of this Society has suffered severely, being cracked in every direction.

It is too soon as yet to speak with certainty of the extent of the earthquake, or of the causes which led to it. So far as present reports go, the province of Assam has suffered most damage, and it is possible that the cause of the earthquake will be found in some movement either along the line of dislocation which separates the Himalayas from the Assam valley, or that which runs along the south flank of the Assam range, at the northern edge of the plains of Sylhet and Cachur.

It is unfortunate that Calcutta does not possess a single seismograph of modern construction. Without one of these it is hopeless to expect to obtain perfectly accurate details, as to time, duration, force, &c., so necessary for a full discussion of the subject.

I enclose two photographs [one is reproduced in Fig. 1] taken immediately after the earthquake, which show the kind of damage that has been caused by it. The vibration of the walls loosened the ends of the beams carrying the massive roofs, which then crushed down, carrying the lower floors with them, the outer walls being usually left standing, but badly fissured. T. D. LA TOUCHE.

FIG. 1.—Calcutta Earthquake, June 12. Messrs. Traill and Co.'s Office, British Indian Street. A Verandah, with portico beneath it supported on pillars in front of the building, has been entirely destroyed.

PAUL SCHÜTZENBERGER.

PAUL SCHÜTZENBERGER was born at Strassburg, and died at Paris on June 28, 1897, at the age of sixty-seven. He first studied medicine at the University of Strassburg, graduating in 1855 with a thesis entitled "Du Système Osseux." Subsequently, however, he devoted himself to chemistry, occupying successively the posts of Préparateur in the chemical laboratory of the Conservatoire des Arts et Métiers at Strassburg, Professor at the Mülhausen High School, Assistant-Director of the chemical laboratory of the Sorbonne, and Head of the chemical department of the Collège de France, where, since 1876, he has occupied the chair of Chemistry. In 1884 he was elected a member of the Academy of Medicine, and in 1888 he was elected to fill the place rendered vacant by the death of Débray in the Paris Academy of Sciences.

Much of his work exhibits the influence of his earlier medical training: for example, his "Chimie Appliquée à la physiologie animale et au diagnostic médical," published in 1864, his work on fermentation (1875), and his well-known researches on the chemical nature of the albuminoids and of the vegetable alkaloids. He also devoted much attention to the chemistry of colouring matters and of their applications, in which branch of science he was one of the first authorities. His book entitled "Des Matières Colorantes," first published in 1866, is, perhaps, his best-known work. He did not confine himself, however, exclusively to organic chemistry, his name being honourably known in inorganic chemistry in connection with the discovery of hyposulphurous acid.

T. E.

NOTES.

THE Queen held a Court at Windsor Castle on Thursday last, at which an address was presented by deputations from several bodies, among them being the Royal Society. The deputation from the Royal Society, consisting of Lord Lister (President), Sir John Evans (Treasurer), Prof. Michael Foster (Secretary), Prof. Arthur W. Rücker (Secretary), Prof. R. B. Clifton (Vice-President), Sir William Huggins, K.C.B. (Vice-President), Mr. W. T. Thiselton-Dyer, C.M.G. (Vice-President), Sir Joseph Dalton Hooker, G.C.S.I., C.B. (Past President), Lord Kelvin, G.C.V.O. (Past President), Sir George Gabriel Stokes, Bart. (Past President), with Mr. Robert W. F. Harrison (Assistant Secretary), was introduced to her Majesty's presence, when the President presented the address, to which the Queen made a gracious reply. The President, Treasurer, and Vice-President Prof. R. B. Clifton, had the honour of kissing her Majesty's hand.

THE Russian Admiral Makaroff, who is well known for his hydrological researches in the Northern Pacific on board the corvette *Vityaz*, has just left St. Petersburg for an Arctic trip. He will take this year the command of a flotilla of seven steamers, which are sent out by the Russian Government for the transport of coal and mixed cargo to the mouths of the Ob and the Yenisei, and for bringing back to Europe various cargo from Siberia. Three of these steamers have strongly-built stems, and will be used to break through the ice, in order to see if the short period of navigation across the Kara Sea cannot be prolonged in this way for a few days. Admiral Makaroff takes with him all the hydrological and meteorological instruments which he had on board the *Vityaz*, and he proposes to sail up the Yenisei in his flagship, and to return by the overland route.

THE fourth summer meeting of the American Mathematical Society will be held, under the Presidency of Prof. Simon Newcomb, at Toronto, on Monday and Tuesday, August 16 and 17. By invitation of the University of Toronto, the meeting will take place in the main building of the University. It has been decided to set apart one of the sessions for the general discussion of the following subjects: (1) The accurate definition of the subject-matter of modern mathematics. (2) The vocabulary of mathematics; the possibility of correcting and enriching it by co-operative action. Members of the British Association are invited to be present at the sessions.

THE nation owes much to the catholic taste and great liberality of Sir Augustus Wollaston Franks, late Keeper of British and Mediæval Antiquities in the British Museum. Archæologists are given further cause for cherishing his memory by the announcement that he has bequeathed to the Museum all the collections lent by him to the Museum or to any other museum, with various other valuable collections and books, conditionally on the Government allowing a remission of probate duty with respect to them. This condition is thus expressed in the will: "And as to these bequests to the British Museum I desire my executors to apply to the Government for a remission of probate duty with respect to them. And if this be not granted I declare my said bequests to the Trustees of the British Museum to be null and void, and I desire and direct that the objects which would otherwise have passed to the British Museum be sold by public auction and the proceeds added to my general residuary estate." Sir Augustus Franks also bequeathed to the Society of Antiquaries of London, of which he was President, a number of rare and valuable books on antiquities, art, history, and genealogy, together with various heraldic manuscripts, drawings, and engravings of ancient seals.

THE Commission, under the direction of Prof. Koch, which investigated the origin of the plague in India, has issued its report, and a few of the conclusions have been transmitted from Berlin through Reuter's agency. It appears that the plague bacillus, outside the human body or certain animals, has very brief vitality; and it does not develop in the absence of oxygen. Rats were proved to be in the highest degree susceptible, and to spread the plague germs and communicate them to human beings. For experiments with the object of producing immunity, apes were used, and it was ascertained that grey apes were as highly susceptible as rats, while brown apes were less so. Immunity was established after a lapse of between five and seven days. Apes thus treated possessed a high degree of immunity, and could endure a large quantity of plague culture, about two milligrammes. For the purposes of serum experiments Yersin serum was employed. Its protective power in the case of brown apes did not exceed eight days. Strong injections of serum proved to be of unquestionable curative efficacy. Haffkine's system of inoculation, which was applied to 1400 patients, is reported to have shown undoubted protective results, although a number of the patients were taken ill in consequence of the inoculation.

HERR ANDRÉE, with his two companions, Drs. Strindberg and Fraenkel, started from Danes Island, on July 11, on their balloon voyage to the North Pole. The weather was favourable, and there was a good breeze, which took the balloon in a north-north-east direction at the rate of about twenty miles an hour. From Danes Island to the North Pole is a distance of about six hundred miles, and the same distance has to be traversed on the other side of the Pole before known *terra firma* can be reached. The risks to which the explorers have exposed themselves are thus very great, for it is difficult to believe that the balloon will keep afloat long enough to permit the expedition to be safely terminated, though the capacity of the balloon was enlarged by 300 cubic metres from 4500 cubic metres before starting, and the silk was greatly strengthened by additional coats of varnish. Since the balloon started, southerly to south-westerly winds have prevailed over Spitsbergen, Norway, and the ice-regions. It is therefore assumed that the balloon went in the direction of Eastern Siberia.

THE Weights and Measures (Metric System) Bill came before the House of Lords on Tuesday. Lord Balfour, in moving the second reading of this Bill, pointed out that the circumstances in which it was proposed to Parliament by the Board of Trade were these. During the Session of 1895 a Select Committee of the other House was appointed to inquire whether any, and, if so, what, changes in the present system of weights and measures should be adopted. The Committee practically confined their attention to the consideration of the metric system, and they agreed to these three recommendations: (1) that the metric system of weights and measures be at once legalised for all purposes; (2) that after a lapse of two years the system be rendered compulsory by Act of Parliament; and (3) that the system be taught in all public elementary schools as a necessary and integral part of arithmetic. The last recommendation could, if thought expedient, be carried into effect without legislation. The Government were not prepared to adopt the second recommendation—that after two years the system be made compulsory. The Bill carried out the first of the recommendations of the Select Committee, and the evidence taken by the Select Committee clearly proved that there was a genuine demand among some of the large trades in some of the important commercial centres of the country for the legalisation of the system, and from the reports of some of our Consuls abroad it seemed to be of considerable importance that the system should be adopted, and to be shown that if adopted it would prove of material benefit to British trade. The Government did not intend to make the system compulsory, and the present Bill was confined

to simply legalising the system for those who required it without going further just now. After a few remarks by Lord Colchester, the second reading of the Bill was agreed to.

THE French Société d'Encouragement pour l'Industrie Nationale has awarded the following prizes:—The Giffard prize of one thousand francs to M. Ducos du Hauron, for his works on photography in colours; the grand gold medal, with Lavoisier's effigy, to M. F. Osmond, for his metallurgical researches; a prize of two thousand francs to M. Rousse for his production of chenille web; and five hundred francs to M. Livache, for his work entitled "Vernis et Huiles siccatives."

WE regret to announce the deaths of the following men of science:—Prof. D. Wilhelm Preyer, the well-known German physiologist; Dr. P. C. Plugge, professor of pharmacology and toxicology in the University of Gröningen, and author of a number of papers on physiological chemistry; Prof. Arminio Nobile, professor of geodesy in the University of Rome, and author of many valuable papers on astronomy; and Prof. Oertel, of Munich, distinguished for his researches on the etiology of diphtheria.

WE notice with regret the announcement of the death of Sir John Bucknill, F.R.S. For nine years he edited the *Journal of Mental Science*, and he was one of the original editors of *Brain*. He was the author of numerous psychological works, and wrote largely on insanity and allied subjects. In the Royal College of Physicians he filled the posts of Censor, Councillor, and Lumleian Lecturer. He was elected a Fellow of the Royal Society in 1866, and was knighted in July 1894, in recognition of his pioneer services in connection with the Volunteer movement.

THE death of Dr. Steenstrup, formerly professor of zoology at the University of Copenhagen, and director of the museum of that city, has already been announced. Dr. Steenstrup (says the *Zoologist*) was born in 1813, and had thus reached the eighty-fifth year of his life. He published much on natural history, but he will be principally remembered by his work on the subject of "Alternation of Generations." He also studied the prehistoric remains found in his own country, both as regards fauna and flora, and in 1866, in conjunction with Sir John Lubbock, contributed a memoir to the Ethnological Society of London "On the Flint Implements recently discovered at Persigny-le-Grand." He was a correspondant of the Section d'Anatomie et Zoologie of the Paris Academy of Sciences.

THE annual meeting of the German Botanical Society for 1897 will be held at Brunswick, commencing on September 21. The sixty-ninth meeting of the German Association of Naturalists and Physicians will be held at the same time. A special feature of the meeting will be an exhibition of scientific apparatus and appliances.

M. GAYON has been elected a member of the Section d'Économie rurale of the Paris Academy of Sciences, in succession to the late Prof. Hellriegel.

PRESIDENT JORDAN, of the Leland Stanford Junior University, has gone to Alaska, with the sanction of the United States Government, for the purpose of branding female seals in order to impair the value of their skins, and thus destroy the industry of pelagic sealing.

WE learn from *Malpighia* that Prof. Penzig, of Genoa, has returned from his botanical expedition to Java and Ceylon with very rich matertals, which have been deposited in the Botanical Museum of the University of Genoa; and that Sig. F. Karo has undertaken a fresh exploration of Southern Siberia, as far as the river Amûr. His botanical collections will be examined and distributed by Dr. J. Freyn, of Prague.

THE detailed magnetic survey of the State of Maryland, begun last year, has been resumed, and is again under the charge of Dr. L. A. Bauer. Special stress will be laid this year upon the investigation of the marked local or regional disturbances in Central and North-eastern Maryland, revealed by last year's work. According to *Terrestrial Magnetism*, there are prospects that a neighbouring State will undertake a similar survey in the near future.

To find the relation between the small variations which distinguish individuals of the same group, and the large differences which separate species and genera, Mr. E. T. Brewster has examined the body measurements of eight races of men, and has determined the coefficient of variability of each dimension for each race (*Proc. Amer. Acad. Arts and Sciences*, vol. xxxii. pp. 269-80, May). His conclusion is "that there is so intimate a causal connection between the characters of individuals and those of the allied groups into which they are combined, that, in proportion as any character is variable in the individuals of one group, it is different in the allied groups."

AN exhibition of navigational instruments has been arranged by the Shipmasters' Society, and will be open from 10 a.m. to 6 p.m. at the Fishmongers' Hall, London Bridge, on August 4, 5 and 6. The promoters have endeavoured to trace the progress made in navigational instruments during the last sixty years. Admission will be free upon presentation of a visiting card. Catalogues will be ready just before the opening.

THE *Ceylon Observer* of June 18 urges the advisability of the appointment in Ceylon of a Government agricultural chemist, and the institution of agricultural experiments under his guidance. It is pointed out that Barbadoes and British Guiana, each with populations and revenue and export trade much smaller than those of Ceylon, have their Government chemists, and naturally those interested in agriculture in Ceylon feel aggrieved at not being placed on a footing similar to that of the people of the two dependencies mentioned.

THE Russian bacteriological stations, or "Pasteur Institutes," are displaying a considerable activity. We find, from the annual report of the Kazan station, that over 82,400 vaccinations against the "Siberian cattle plague" have been made during the past year, and that not only educated agriculturists but also the peasants begin to vaccinate their cattle. The Kazan bacteriologists make use exclusively of the bacterial vaccine of Profs. Lange and Cienkowski, which is prepared in the field laboratories, on the spot, the day before vaccination takes place. Demands for it come from the surrounding provinces, even from East Siberia. Researches into rabies and tuberculosis among cattle were carried on at the same time.

THE researches lately published about the supposed new element, "lucium," have induced Prof. Chroustchoff to revise the work he had made in 1887 upon what he then supposed to be a new element, "russium," also obtained from the monazite sands of North Carolina. He gives a short report about his last investigations in the *Journal* of the Russian Chemical Society (xxix. 3). Having obtained during the last eight years about 25 kgr. of rare earths, he extracted from them 35 grammes of a substance which has all the properties of "russium." Its equivalent is equal to 70·5, and its spectrum is characterised by a group of green and violet lines. A detailed description of all the experiments will soon follow. Prof. Chroustchoff also mentions that cerium, after it has been freed of all traces of thorium and other impurities, can be separated into several fractions differing from each other by their physical properties, and having, respectively, the atomic weights of 138, 140, 142, 146, and 156·5. It also seems that besides the two components of didymium, described by Auer, there exists a third component. The note contains a list of all the rare earths hitherto obtained, or supposed to exist.

THE article on "Styles of the Calendar," in a previous number of NATURE (No. 1443), has brought us several letters with special reference to the time of adoption of the "new style" by England and Scotland. One correspondent writes: "Scotland, like England, adhered to the Julian Calendar till 1752. What has caused the error . . . is the impression that the Act of the Scottish Parliament in 1599, 'for the year of God to begin the 1st of January yearly,' introduced the Gregorian Calendar into Scotland. But all that that statute did (as indeed its title indicates) was to enact that the year should begin in accordance with classical usage, on the 1st of January, and not, as was the mediæval custom, on the 25th of March." Another correspondent, besides endorsing the above, adds: "That what is meant by 'new style' is, of course, the adoption of the Gregorian reckoning; . . . this was done by England and Scotland together in September 1752, by dropping eleven in the numbering of the days. Accordingly, old style was in use in Scotland till 1752, and indeed is by no means wholly disused yet. . . ." The author of the above-mentioned article, Mr. W. T. Lynn, writes: "The alteration made by the Scotch in 1600 was restricted to the adoption of January 1 instead of March 25 as the first day of the legal year. This was effected in England in 1751 by the same Act of Parliament which provided that the Gregorian reckoning should henceforth be used in Great Britain. Perhaps I may point out the erroneous statement in the subject in the current (ninth) edition of the 'Encyclopædia Britannica,' where we read (vol. iv. p. 677): 'In Scotland the new style was adopted from the beginning of 1600, according to an Act of the Privy Council in December 1599.' The writer may have had in his mind what he was speaking of in the preceding sentence on the alteration in the commencement of the year (where, by the way, there is a slip or misprint of April 25 for March 25), but the expression 'new style' could not apply to that."

MR. A. T. DRUMMOND, writing from Kingston, Canada, says:—"In the course of an inquiry into the subject of old age pensions in Canada, I have had occasion to investigate, among other matters, the proportion which those who had in that country attained sixty years of age and upwards bore to the whole community. The result showed a constant increase in this proportion from 1851 onwards, as indicated by the following figures:—1851, 3·70 per cent.; 1861, 4·49 per cent.; 1871, 5·10 per cent.; 1881, 6·32 per cent.; 1891, 7·01 per cent. In the earlier years given, the proportion relative to their respective populations was always somewhat greater in the Province of Quebec than in the Province of Ontario; but in 1891 this was changed by those in Ontario reaching 7·16 per cent. Nova Scotia's proportion has always stood relatively high, and in 1891 was 8·91 per cent. Whilst emigration and immigration have each in turn tended to increase or diminish these proportions, and to qualify any conclusion which may be drawn, the general impression from these figures is that the population coming within the old age limit is increasing. This may be fairly considered as due to better food, improved sanitation in houses, the use of new methods and appliances in daily life which result in less wear on the system, and the more careful attention to rules of health which better education and greater prosperity have brought about."

EXPERIMENTAL farms similar to those supported by various continental Governments and in the United States have, unfortunately for British agriculture, not yet been established in this country. Researches in pots and plots are, however, carried out by a few societies and technical colleges having the interests of agriculture at heart, and the results are made accessible to farmers. The Glasgow and West of Scotland Technical College is one of the institutions which encourages work of this kind. A report now before us shows the results of manuring experiments conducted last year on farms in the south-west and centre of Scotland, under the direction of Prof. R. Patrick Wright. The report will, doubtless, prove as helpful to agriculturists as the official bulletins are to the farmers in America.

AN electrical method of determining the moisture content of arable soils is described by Messrs. M. Whitney, F. D. Gardner, and L. J. Briggs, in *Bulletin* No. 6 of the U.S. Department of Agriculture (Division of Soils). For a long time the importance of having a trustworthy and convenient method for determining the amount of moisture in soils has been recognised. It is pointed out that the rain does plants but little positive good until it enters the soil, where it can be absorbed by their roots. A record of the actual amount of water in the soil from day to day would, therefore, give the absolute value of the moisture conditions under which plants are growing, and even without reference to rainfall data it would show, if the character of the soil was understood, whether the conditions were favourable or otherwise for the crop. The difficulty has hitherto been to make this determination easily; for though various methods have been tried, very little success appears to have been achieved. The method described in the present bulletin seems, however, to be practicable and readily carried out. It consists in burying specially-constructed electrodes in the soil, so that by measuring the resistance to the passage of a current through the soil the amount of moisture in the soil can be determined. The possibility of using the electrical resistance of soils for the determination of moisture was suggested to the authors some years ago by the necessity of thoroughly grounding lightning rods, telephones, and telegraph lines. If these are not carried to a considerable depth, so that the terminals are constantly in a moist soil, the lines do not work in dry seasons. A fair number of observations have been made with the instruments described, and they appear to be satisfactory. The work was begun before the modern conceptions of the nature and principles of salt solutions and electrical conductivity had been developed, and it has been brought to a successful termination by regarding the soil as a difficultly soluble compound, and the soil moisture as a salt solution derived therefrom. The research is thus not only interesting from a practical point of view, but also from the standpoint of physical chemistry.

IN the *Bollettino della Società Sismologica Italiana*, Signor G. Agamennone gives an account of the determination of the velocity of propagation of the earthquake shock which visited Amed (Asia Minor) on April 16, 1896. This investigation receives additional interest from the fact of the earthquake being the first occurring in the district, for the determination of whose velocity trustworthy data exist, the time of the Imperial Observatory of Constantinople affording an accurate means of timing the passage of the shock. Observations in Asia Minor itself gave a velocity of 1200 metres per second; but by comparing the observations with those made at Padua, a velocity of 3200 metres per second was obtained for the phase of reinforcement, and 2400 for the maximum disturbance.—In another part of the same journal, Signor Agamennone describes his photographic tromometer for registering seismic and other disturbances by means of a freely suspended heavy pendulum. In the present modification of the original apparatus, the components of the disturbance in two rectangular directions are separately registered.

WE learn from the *Annalen der Hydrographie und maritimen Meteorologie* for June that a new system of storm signals is to be established along the Dutch coasts. Nearly forty years ago the question of storm warnings was discussed by Prof. Buys Ballot at a meeting of scientific men at Bonn, and he subsequently adopted the method of cone and drum signals similar

to those introduced by Admiral FitzRoy in this country. But in the year 1866, when these signals were temporarily discontinued here, and shortly afterwards re-established in a slightly modified form, Buys Ballot adopted an apparatus called Aeroclinoscope, a kind of semaphore with mast and arm, by means of which the direction and magnitude of the barometric differences from the normal conditions between certain places were made known. The system to be adopted during the current year is similar to that used on the German coasts, viz. a ball, two cones and two black flags by day, and red lamps by night. They are to be established at thirty-nine stations; and with a view to making the system as useful as possible, additional telegraphic information is received at the central office in Utrecht twice or thrice daily from various countries, to supplement the observations made in Holland. Much credit is due to the Dutch Meteorological Institute for undertaking this expensive work, for the general benefit of navigators.

THE Central Meteorological Office of France has just published in its *Annales* a useful catalogue of all meteorological observations made in France from the earliest times down to the year 1850. The catalogue has been prepared at a great cost of time and labour by M. Angot, by means of personal visits and by circulars issued through the Ministry of Public Instruction, and contains particulars of observations made at 241 stations. If similar catalogues were published for all countries, they would greatly facilitate meteorological researches, especially those relating to periodical phenomena, which are often frustrated for the want of knowing where to find observations of long duration.

MR. R. THAXTER contributes to the *Memoirs* of the American Academy of Arts and Sciences a very interesting monograph of the *Laboulbeniaceæ*, an order of Ascomycetous Fungi which shows a remarkable analogy in structure to the highest family of Alga, the Florideæ. The *Laboulbeniaceæ* are all minute parasites on living insects, chiefly aquatic; the larger number are American; and for our knowledge of the family we are largely indebted to Mr. Thaxter. Of the twenty-eight genera described in the monograph, only nine have at present been found in the Old World. The main body of the fungus is usually quite simple in structure, is composed of several cells, and is attached to the chitinous integument of the insect, not penetrating its tissue in the form of a mycelium. The sexual organs of reproduction are antheridia and procarps, the latter being multicellular structures containing a carpogenic cell, and bearing a trichogyne resembling that of the Florideæ. After fertilisation the asci are developed from the carpogenic cell, enclosed in a perithecium which resembles in many respects the cystocarp of the Florideæ. The spermatozoids or pollinoids are very minute, often rod-shaped bodies, and attach themselves in large numbers to the trichogyne, though actual fusion has not been observed. The trichogyne varies much in complexity of structure. It is never in direct communication with the carpogenic cell; the fertilising process must be conveyed through one or through several cells before it reaches the carpogenic cell. The author believes that the nucleus of the spermatozoids must pass from cell to cell through the length of the trichogyne, before impregnating the female nucleus in the carpogenic cell, a phenomenon which he states to be without its parallel in either the animal or the vegetable kingdom.

A NEW edition (the fourth) of Mr. Marriott's "Hints to Meteorological Observers" has just been issued by Mr. E. Stanford.

THE first report of Mr. J. C. Willis, the Director of the Royal Botanic Gardens, Ceylon, and successor to the late Dr. Trimen, has just come to hand.

THE Report for 1895 of the Botanical Exchange Club of the British Isles (just received and dated 1897), by Mr. W. H. Beeby, contains a number of notes on critical species, as well as a record of many fresh localities.

THE current number of the *British Medical Journal* contains a list of the papers to be read, and the discussions announced to take place, at the forthcoming meeting of the British Medical Association in Montreal.

THE tenth annual report of the Scientific Society of the University of North Wales, for the Session 1896-97, has reached us. It contains brief abstracts of the papers and addresses which were given during the Session.

THE McGill University, of Montreal, has just issued the announcement of its Faculty of Applied Science for the Session 1897-98. The pamphlet contains all the preliminary information likely to be of use to those who may be thinking of taking instruction in science at the University.

MESSRS. SONNENSCHEIN AND CO. announce as in preparation "The Laws of Thought," by Mrs. Boole, who, since the death of her husband, has been engaged in translating the results of his researches into language intelligible to all familiar with the elements of arithmetic and geometry.

MESSRS. BLISS, SANDS, AND CO. will shortly commence the publication of a new scientific series, entitled "The Progressive Science Series," edited by Mr. Frank Beddard, F.R.S. The volumes will aim at pointing out the lines of future discovery, but they will also contain sufficient historical and expository matter to enable students and investigators to learn what has been done. The late Prof. Cope wrote a volume on "Vertebrate Palæontology" for the series, which will also include a volume by Dr. Geikie on "Earth Structure"; one by Dr. St. George Mivart on "The Groundwork of Science," and one by Prof. Bonney on "Volcanoes." Other volumes are in contemplation on heredity in relation to crime; theories of matter; and the relation between science and religion. The series when completed will comprise works on every branch of science, some half-dozen or more being published in each year at first.

AMONG the articles and other publications which have come under our notice within the past few days are:—"Heredity and Neurosis," by Dr. Geo. H. Savage (in *Brain*, Parts lxxvii. and lxxviii.). This (the presidential address to the Neurological Society of London for 1897) is a paper in which the relationships of the neuroses are compared, and the lineal descent of these disorders of mental function are traced. The article is thus a valuable contribution to the facts of evolution.—"The Structure of Cross-striated Muscle, and a suggestion as to the Nature of its Contraction," by W. M'Dougall, in the *Journal* of Anatomy and Physiology (July). The paper is illustrated with half-tone reproductions of more than fifty photo-micrographs of sections of muscles and fibres. The suggestion as to the cause of contraction is formulated as follows: "Contraction is the result of an increase in the volume of the fluid contents of the sacromere, and relaxation is accompanied by a diminution in their volume."—A detailed report on the violent Laibach earthquake of April 14, 1895, illustrated by four plates and forty-two text-figures, is given by Dr. Franz E. Suess, in the *Jahrbuch d. k.k. geol. Reichsanstalt*, Vienna (vol. xlvi.). The report extends over nearly five hundred pages of the *Jahrbuch*, An earthquake said to resemble in many points the disturbance which Dr. Suess discusses, is reported to have occurred at Laibach shortly before seven o'clock on the morning of Thursday last, July 15. Considerable damage appears to have been done.—A finely-coloured geological and topographical map of the northern part of the Lake of the Woods and adjacent country has been published by the Geological Survey of Canada.

A COMPARISON between the magnetisation and associated change of length of iron and steel (*Längenänderung und Magnetisirung von Eisen und Stahl*) is the subject discussed by Dr. Klingenberg in his "Inaugural Dissertation" at Rostock University. The magnetisation and elongation of various wires were measured simultaneously under varied conditions of field-strength, longitudinal loading, and mechanical jarring, and the general conclusion was arrived at that there exists a pronounced similarity between the two associated phenomena. In its details the investigation is, to a large extent, a repetition of the well-known experiments of Joule, Bidwell, Ewing and others; but the peculiar merit of Dr. Klingenberg's work lies in the coordination of the two classes of phenomena simultaneously studied. It is a careful discussion of a sound piece of experimental work. In his concluding sections the author touches upon the question of magnetic strain, which Dr. Jones has more elaborately worked out in a paper recently published in the *Philosophical Transactions*. An ingenious attempt is also made to coordinate the curiously contrasted magnetic phenomena in iron, nickel, and cobalt in terms of the shape and orientation of the molecular magnets, whose rotations are believed to be the most essential feature in these phenomena. On the assumption that the iron molecules are ellipsoids magnetised, some along the long axis, others along the short axis, the author shows how the former will have preponderating influence in weak fields, while the latter will tell more and more in strong fields. In nickel, the assumption is that the ellipsoids are almost exclusively magnetised along the short axis. On these assumptions the dilatation phenomena in iron and nickel, the Villari Reversal, &c., find ready enough explanation. The peculiarities of cobalt are stated to be explicable on the same lines.

IF a fused solid substance be cooled below its melting point in a tube, and crystallisation then induced at one end, the rate at which this is propagated along the tube may be taken as a measure of the velocity of crystallisation. Gernez has found, with phosphorus and sulphur, that this velocity is proportional to the degree of super-cooling. Since, however, the surface at which the crystallisation actually takes place is always at the melting temperature of the substance, G. Tammann considers that the velocity ought to be independent of the degree of super-cooling, and in the current number of the *Zeitschrift für Physikalische Chemie* publishes the results of some experiments on the point. Using benzophenone, which was not quite pure, he finds that the rate of crystallisation increases with the super-cooling until the latter amounts to about 20° (or less with a purer sample). From this point the velocity remains constant until the super-cooling is so great that the heat evolved by the solidification is insufficient to heat the solid formed to the melting temperature. *The rate of crystallisation diminishes rapidly from this point onwards.* For example, at −40° a crystal of benzophenone introduced into the super-cooled substance changes so little that an observer might easily imagine that the liquid was at its melting temperature; on allowing the temperature to rise crystallisation begins, slowly at −35°, rapidly at −25°. Phosphorus, again, solidifies at least one hundred times more slowly at 0° than at 24°. These observations seem to provide a fresh point of resemblance between so-called physical and chemical changes, since, of the latter, it has long been known that even the most energetic proceed extremely slowly at sufficiently low temperatures.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Master Jan. B. Dickson; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. A. E. Snooks; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Mr. W. Meears; a Black Lemur (*Lemur macao*), a Black-headed Lemur (*Lemur brunneus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, presented by Mr. R. A. Todd; a Roseate Spoonbill (*Ajaja rosea*) from South America, presented by Mr. E. J. Ghay; a Common Peafowl (*Pavo cristatus*, ♂) from India, presented by Mr. A. Burnell Tubbs; a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, presented by Mr. Edward Hawkins; a —— Cassowary (*Casuarius*, sp.?) deposited; a Thar (*Capra jemlaica*), a Red Deer (*Cervus elaphus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

CAMBRIDGE OBSERVATORY REPORT.—Sir Robert Ball records the completion and publication of the zone 25° to 30°, which forms part of the "Catalog der Astronomischen Gesellschaft." In it are the places of 14,464 stars, the result of about 47,570 observations, the Observatory having been engaged in this work during the last quarter of a century. The complete catalogue containing the individual observations is very nearly ready for press, and will be printed as soon as the volume already in the printer's hands has been issued. Mr. Hinks has undertaken a detailed comparison of the places of 671 stars in the Cambridge and Berlin Catalogues lying in the zone +24° 50′ to +25° 10′. The result seems to have been very satisfactory, the differences of declination being very small and apparently accidental, while in the case of the right ascensions small but systematic differences depending on the magnitude of the stars have been found. The designs for the new photographic telescope have been completed, and the instrument is being pushed forward; it is mentioned that probably the new building to contain it will be erected during the course of the summer. With regard to the Newall telescope, Mr. H. F. Newall tells us in his report, which is attached, that he has met with great difficulties in bringing his spectroscope into successful working order. The discrepancies were, however, securely traced, and the necessary alterations made, with the result that the photographs now obtained are considered very satisfactory. Some of the results already obtained, with regard to the motion of some stars in the line of sight, are given by him in his report, from which we make the following extract:—

Star.	No. of plates.	No. of lines employed.	Velocity deduced.	Potsdam results.	
				Vogel.	Scheiner.
α Tauri	1	5	+49·2	+47·6	+49·4
α Orionis... ...	1	4	+10·6	+15·6	+18·8
α Can. Min. ...	2	5 (each)	{ −3·5 −4·9 }	−7·2	−10·5
β Geminorum	1	5	−0·7	+1·9	+0·4
γ Leonis... ...	2	3 (each)	{ −42·3 −37·5 }	−36·5	−40·5
α Boötis	7	7 (each)	{ −5·9 −6·8 }	−7·0	−8·3

In the last star in this list Belopolsky obtained the value −5·7, while Keeler's was slightly larger, namely −6·8.

The term of five years for which Mr. Newall placed his services at the disposal of the University in connection with this instrument has now been completed, and our readers will be glad to hear that he has renewed his proposal for another similar period.

NEW VARIABLE IN COMA BERENICES.—In a communication to the current number of the *Astronomischen Nachrichten* (No. 3433), Mr. T. D. Anderson gives details of the variable star he has recently discovered. It seems that on May 29 of this year he observed a star in the constellation of Coma Berenices, in position R.A. = 12h. 23·0m., Decl. + 32° 17′ ± 1′ (1855·0). This star was not found mentioned in the BD., but its magnitude was estimated as exactly the same as BD. + 31° ·2373, namely 8·8. About ten days afterwards Mr. Anderson again observed the star, but could detect no change whatever in its brightness. Observing with his 2¼-inch refractor some four weeks later—on July 9 and 10—he was still unable to see the star, although BD. + 32°·2248 and 2253, which were both much brighter than it on May 29, were clearly visible. The magnitude of this new variable must have been lower than 9·5.

THE PHOTOGRAPHS OF THE MOON TAKEN AT THE PARIS OBSERVATORY.

THE second part of the Photographic Atlas of the Moon, published by the Paris Observatory, has just appeared. The photographs were taken at the Paris Observatory, by MM. Lœwy and Puiseux, and the negatives were exhibited at the Académie des Sciences in 1895. The satisfactory reception of the first series has induced MM. Lœwy and Puiseux to continue the work, and recently they have contributed two papers to the Académie des Sciences, of which the more recent deals with some new studies concerning the history of the lunar surface. We cannot do better than give a translation of this second communication.

"We have recently had the honour of presenting to the Academy the second part of the Photographic Atlas of the Moon, published by the Paris Observatory. We endeavoured on this occasion to enumerate, and to describe briefly, the principal objects which are represented therein. The object of this second note is to point out where the new maps seem to us to usefully complete the old ones, and to throw new light on the history of the formation of the lunar crust.

"We endeavoured before to ascertain what density of atmosphere might be conceded to the moon. This density being very feeble, it follows that the surface of our satellite must now be at a low temperature—at least, near the poles. There is even cause to ask if it is not totally or partially covered with ice. The most complete representation of the southern region, which is shown on Pl. vi., inclines us to the opposite view—that is to say, that the presence of a great accumulation of ice must be considered improbable, as well for the polar caps as for the equatorial region. One is, therefore, led to imagine that the total moisture on the surface must have disappeared, undoubtedly by penetration into the interior of the globe, before the polar regions sank permanently beneath freezing-point. It is simple enough to imagine this great absorptive capacity of the lunar crust for liquids. The cooling of our satellite, more rapid than that of the earth, has shortened the period of condensation of the vapours. The water was filtered as fast as it was formed in innumerable volcanic orifices, which seemed prepared to receive it. Pl. vi. gives us an idea of the abundance of these openings in the neighbourhood of the pole, and one is led to think that the same constitution must have existed on the whole of the moon previously to the formation of seas.

"The first pages of the Atlas gave us a fairly large number of rectilinear furrows, running without deviation across mountainous spaces, and subjected, in every region, to one or two principal orientations, in such a way as to constitute a sort of network. We have seen that these furrows could be replaced exceptionally by ridges presenting a similar condition. This appearance becomes, on the contrary, very frequent in Pls. vi. and vii., comprised in the present part. We see there signs of a strong lateral pressure, which has obliged two fragments of crust, brought into contact, to straighten their borders, or to encroach on one another. It is easy to see that the elevations thus formed by a local increasing of thickness are an efficient barrier to the formation and regular expansion of the walled plains. These tracings can be followed nowhere better than in the southern region, which is the best preserved of all, and has not participated in the general depressions of the rest of the crust.

"These depressions, whence the seas originated, are seen by crevices which practically fix the contour limit, and which are visible to us under favourable conditions. Pl. viii. shows a curious example of parallelism between these crevices and the prominent ridges which are seen to run great distances on the surface of the seas. This fact, and several others, lead us to think these undulations, in some respects inverse, as having a common origin.

"In fact, we observe in Pls. ix. and x. mountainous regions modelled on the same plan as their neighbours, offering, in point of view of relief, a perfect continuity with them, but distinguishing themselves by a darker colour. The situation of these markings on the edges of the seas gives us reason to believe that they have been occupied temporarily by liquid surfaces, and that these have retreated, before solidification, into more restricted limits. There would thus have been, in the inundated region, change of colour without appreciable alteration of relief. Taking into account the great delicacy of photography for differences of luminous intensity, it seems possible with its aid to distinguish the successive periods in the retreat of the seas of our satellite, as the palæontologists have successfully done with our globe.

"All the varieties of walled plains which we have come across so far are represented in the second part. There are some, like Gassendi and Eratosthenes, showing an irregular interior, and where the movement of the surface, which has brought them to their present state, has left very visible signs everywhere. Others, like Archimedes and Plato, have been invaded by interior overflowings, which have elevated and levelled the bottom. Elsewhere, as in Stadius and Guerike, the side has been corroded and partially destroyed. Copernicus and Aristillus, the walls of which rise considerably above the seas, are exceptionally interesting by the intensity of the upheaval, of which they seem to have been the centre, by the violence and long duration of the eruptions which have taken place within their walls, and which have modified, in a very extended way, the colour of the surface around them.

"However great the varieties in character of the walled plains, they are not always sufficient to completely explain their age and origin. We are only able to prove in each case the last term of a series of metamorphoses.

"The more or less perfect state of preservation of the walled plains is, however, an important indication always worth noting. The eruptive walled plains, with elevated borders and central mountains, cannot very well be of a great age. This relative soundness is apparently in favour of a more recent date, and other indications can be added to this. We see, for example, prominent formations, isolated in the middle of the seas, presenting generally a great regularity, as if they had been created in a crust, which became more homogeneous by liquid effusion. The absence of parasitic walled plains on their borders seems to show that at the time of their elevation the appearance of volcanic orifices had already become an exceptional thing. The great depression of their interior plains beneath the neighbouring level indicates a later solidification than that of the seas. The white streams which escape from them and stretch out, remaining visible on the surface of the seas, indicate notably Tycho, Copernicus, Aristillus, as having been the seat of great eruptions before all the parts of our satellite were fixed at their present level.

"The great walls totally effaced, partly destroyed, or filled up, perchance belong to a more remote time, because they have been subjected to greater modifications. The two principal causes of ruin have been the formation of parasitic orifices, and the overflowing of lava in the interior cavity. This second cause is without doubt that which has produced the most intense effects. By it a number of the great walls have come to be mixed up with the seas, and to possess only an obscure individuality. This slow destruction, which can be recognised in all its degrees, forces us to consider the majority of walled plains as more ancient than the seas. But the part of the local eruptive actions has, without doubt, extended over a much longer period than the overflowing of the lava. The abundance of small orifices surrounded by white borders, on the elevated plateaus as well as on the actual bed of the sea, leads us to look upon these violent eruptions as one of the most persistent phenomena in lunar history.

"Perhaps the linear features of the surface of the moon, very much neglected by selenographers in favour of the walled plains, offer, as well as these, a solid basis for establishing a chronology.

"In the first place, we will begin with prominent elevations, notably visible near Clavius, which have determined the polygon outline of the walled plains, and offered an almost invincible resistance to all the subsequent movements of the surface. By the side of these may be placed the rectilinear furrows in the region of Albategnius, representing, like the elevations, more or less intimate joints between the broken fragments of a primitive crust, but more easily destroyed or masked by recent eruptions. The spacious valleys which are met with near Herschel and Bode, across the Alps, are furrows enlarged by the movement of one of the fragments.

"The deep rectilinear crevices of Ariadæus and Hyginus, progressively narrowed at their extremities, indicate dislocations which have occurred in a crust already thicker and more coherent. The intercrossing systems, like those of Triesnecher and Ramsden, reveal the antagonistic influence of gravity and eruptive elevations.

"The parallel fissures which run to the outskirts of the

mountainous regions correspond to the successive depressions of the regions occupied by the seas. The obstruction of these fissures by the overflowing of lava has given most of them the aspect of prominent veins which can be seen branching at the surface of the seas, or crossing the middle part of some great walled plain. But amongst the concentric crevices at the seas, those which have remained open must have been contemporary with the most recent movements of the soil.

"If, however, we try now to compare and to make these two orders of parallel facts, often associated in the same region of the moon, agree, we shall be brought back by a slightly different way to the same chronology which we have already shown to be the most probable.

"The rectilinear furrows, transformed into elevations by a strong lateral pressure, or, on the contrary, into large valleys by a gradual disjunction, belong all to the first period—that in which the crust possessed a certain degree of mobility in the horizontal direction.

"The second period pertains to the forces of elevation which acted on extended areas, irregular as regards their boundaries. At this period great mountains begin to be formed. There are few forms sufficiently characterised which can be traced back to this obscure epoch of transition.

"Nevertheless the elevated regions with a scarcity of walled plains, covered with scoriæ which has accumulated without any regularity, can give an idea of what the general aspect of our satellite must have been at that time. The group of the Apennines is undoubtedly the most important vestige which remains from that epoch. In a third period appear conical intumescences, the first outlines of the walled plains. These obtain their real actual physiognomy by the progressive depression and the partial submersion of their central region.

"The fourth period, the grandest and most durable in its effects, brings about the destruction of a great part of the anterior relief, and gives to the whole of the lunar globe an aspect differing very little from that which we see now. The depressions, caused by the general contraction of interior fluid, include at once the vast regions which we designate by the name of seas, and cause immense quantities of lava to flow back in uniform sheets to the surface. The mountainous plateaus appear as isolated groups, and in the intermediate spaces a mass of furrows and walled plains disappear by submersion. An idea of the importance of the change brought about, will be gathered by comparing the polar and equatorial regions, so unlike to-day, but which, without doubt, formerly bore the same aspect.

"The first new features which become visible in the uniform plains thus formed are crevices which follow their borders and increase with the progress of the depression, until a fresh overflowing of lava takes place, stops them up, or transforms them into prominent lines. The most recent cracks can remain open, or become visible by the difference of altitude which exists between the two edges. This fourth period brings the lunar crust to a more stable condition, of which it did not actually appear possible to foresee the end. The local eruptions always become visible across the crust already solidified, and complete the fifth period. In the mountainous parts they create parasitic orifices, which degrade and render unrecognisable the ancient formations. In the seas the volcanic forces, which are obliged to cross a thicker and more homogeneous crust, enforce the appearance of regular cones, generally transformed into little walled plains by the depression of their centre. Some large formations, such as Copernicus, have probably appeared in this way. Most of the walled plains thus created in relatively recent times can be distinguished by their isolated situation in the middle of a plain, by the regularity of their form, by the white borders which surround them, and which indicate violent eruptions experienced in the neighbourhood of their centre.

"These inductions can, naturally, only acquire a convincing nature if the objects in question, or at least their exact image, are before us. When Beer and Mädler published their great work on the moon in 1837, they limited themselves to simply stating facts. They themselves acknowledged they had tried to eliminate from their descriptions all that could lead to a tendency to theorise, and favour any particular view concerning the actual state of the moon and the history of its metamorphoses. It has seemed to us that the editor of a photographic document was not bound to such reserve. The authenticity of the facts on which he relies can be absolutely verified. Placed in the presence of a true and impartial reproduction, the reader is in a position to judge for himself, and to have an independent opinion. It is not wanting in any respect to him, but to facilitate this task, that we try to formulate the very varied problems which the examination of the moon suggests, to report the most curious facts, and the examples which are best for determining the choice between the different possible theories. We have endeavoured to do this in the notice which accompanies the second part of the Atlas, of which the preceding lines contain the principal ideas."

THE INTERNATIONAL CONGRESS OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

THE recent congress of Naval Architects and Marine Engineers, which was brought to a conclusion on Thursday of last week, July 15, has taken the place of the usual summer meeting of the Institution of Naval Architects. As our readers are aware, the two preceding summer meetings of this Institution have been held respectively in France and Germany, and on both occasions the meetings have been of more than usual brilliancy and importance. The generous hospitality extended to members of the Institution in Paris, Berlin, and Hamburg created a very natural desire on the part of those entrusted with the conduct of the affairs of the Institution to do something to show that the sympathetic and friendly feelings aroused extended beyond mere expressions of gratitude conveyed in speeches and formal documents. It was determined therefore to hold a congress in London this year, at which naval architects and marine engineers of all nations should be the honoured guests of the Institution. The Earl of Hopetoun, the President of the Institution, threw himself into the work of forming a reception committee with characteristic enthusiasm, and was most ably seconded by Mr. George Holmes, the Secretary of the Institution, on whom, naturally, the chief burden of the work has fallen. A subscription list was opened, and, being most liberally supported by the leading members of the Institution, there was no lack of the most needful feature for success in all operations of this nature. The result has been one of the most brilliant and successful gatherings yet held by a technical society. Foreign delegates, representing the leading men in the twin sciences of naval architecture and marine engineering, attended in response to the invitation of the reception committee, and the whole proceedings were so perfectly organised by Mr. Holmes and his staff that the congress passed off without a break in the continuity of success.

In a grand function of this nature it is the social and international aspect which attracts attention rather than the scientific bearing. When the Queen extends hospitality, when the heir to the throne presides, even the most austere seeker after scientific truth may, perhaps, relax, and lose sight for a time of the sterner aspect of the meeting. Two sittings were held at the Imperial Institute for the reading and discussion of papers, but undoubtedly the chief features of the congress were the reception of the members and foreign delegates by Her Majesty at Windsor, the inspection of Portsmouth Dockyard, and the subsequent cruise in the Solent on the mail steamer *Mexican*, the conversazione held at the Mansion House by the Lord Mayor and Lady Mayoress, the reception by the First Lord of the Admiralty at his official residence, the Honourable Mr. and Lady Idina Brassey's soirée at Lord Brassey's house in Park Lane, and the concert at the Queen's Hall, in which the magnificent Yorkshire choir played so prominent a part, and at which Madame Albani was the principal singer. In addition to this there was a more business-like visit to the Docks, an opening reception on the first evening of the congress at the Hotel Cecil, and the annual dinner of the Institution. It is, however, not within our province to chronicle these delights; but before glancing at the more business part of the congress, we may call attention to the excellent effect produced by international gatherings of those devoted to applied science drawing closer the ties of friendship. The leading shipbuilders and marine engineers are men of high position and influence in the country. Their visits to France and Germany have led to the most pleasant relationships, and these have been cemented by the visit of so many foreign delegates during the recent congress. These things make for peace; so that when a section of the daily press, at home or abroad, is occupied in its frequent endeavour to stir up ill-feeling between different peoples, it will find its un-

amiable efforts less likely to be crowned by success. In support of this view, we would call attention to the generous letter of thanks from the foreign delegates which appeared in last Saturday's *Times*.

The first sitting for the reading of papers was held in the Imperial Institute on Tuesday, the 6th inst. The Prince of Wales, as President of the congress, delivered an opening address, and was followed by the First Lord of the Admiralty, and by Lord Hopetoun, the President of the Institution of Naval Architects. The congress was then divided into two parts, that relating to Naval Architecture being held in the Main Hall, whilst the Marine Engineers took possession of the East Conference Hall. The first paper taken in the former section was a contribution by M. Émile Bertin. It was on "hardened plates and broken projectiles," and discussed the effect of "Harveyising" steel armour. This paper was to some extent based on one read previously by Mr. C. Ellis, of Sheffield. The author supposed that a cap placed on the point of a projectile would assist in penetrating the plate. This system was first tried in England and met with approval, and judging by M. Bertin's paper he supports the device. The practical success of the Harvey system of treatment—which is in the nature of case-hardening—is now so fully established that it is needless to follow up the subject in this brief sketch; but, to those who wish to pursue the matter in its more scientific and abstract features, the paper in question will afford both instructive and interesting reading. It must, however, be taken with the illustrations.

"Non-flammable wood" was the subject of the next paper, contributed by Mr. C. Ellis, of Sheffield. In the process de-described, timber is placed in a cylinder and a vacuum is formed. Steam is then admitted, and the moisture is drawn off with it. A vacuum is then again formed, and a fine spray of a liquid containing certain salts is injected into the cylinder, the fibre being thus thoroughly impregnated by the chemicals. Under these circumstances the wood will not support flame. So far there does not appear to be anything very novel in the principles of the process, though there may be in the details, and possibly the "certain salts" cover an important point upon which information was not given in the paper. The advantage of wood used in warships being "non-flammable" is beyond question.

In the Marine Engineering Section, at which Sir Edward Reed presided, Sir John Durston and Mr. J. T. Milton contributed the first paper, which comprised "a review of the history of the progress of marine engineering in the Royal Navy and Mercantile Marine from the foundation of the Institution of Naval Architects to the present day." This was one of those elaborate contributions to the literature of the subject which will be invaluable to the historian of the future and the writers of books in general, but which it would be foolish to attempt to abstract here. Its title is sufficient to denote its scope, and the high reputation of the authors is sufficient to stamp the paper as a standard work. A paper by M. Sigaudy was next read. It treated upon water-tube boilers in high-speed ocean steamers, and gave details of actual practice in small vessels, and proposals for larger ones, strongly supporting the suggestion that small tubes, or, as they are called in England, "express" boilers, should be used on ocean-going vessels.

On the second day of the congress, Wednesday, July 7, the Naval Architecture Section was opened by the reading of a paper by Sir Edward Reed, on the mathematical theory of naval architecture. This was another monumental paper worthy of the subject and the year. It led to a discussion largely of a nature complimentary to the author, who had managed to compress a large mass of information of a general nature within the limits of his memoir, and to do this without making the subject repulsive by its dryness to the average reader of such contributions. Captain Tuxen, Chief of the Construction Department of the Royal Danish Navy, next read a paper, in which he described some of those admirable railway ferry steamers which break their way so remarkably through the ice-bound waters of his native land. The last paper read in this Section was contributed by Mr. J. Johnson, of Göthenburg, and dealt with "graphic aid in approximating hull weights."

In the Marine Engineering Section, in which Sir Nathaniel Barnaby occupied the chair, the proceedings were opened by Mr. G. W. Manuel reading a paper on "crank and other shafts." Mr. Manuel, as is well known, is the Chief of the Engineering Department of the P. and O. line, and his success in regard to the absence of accidents to the shafting of vessels under his charge has been remarkable. In this respect, however, he has been fortunate in being able to give such substantial proportions to this feature in machine design that success is not altogether to be attributed to good fortune; indeed, it has been said that if Mr. Manuel were to make his shafts of cast iron they would be reasonably safe. By aid of diagrams many instructive illustrations were given of the manner in which shafts fail, often by fatigue. Mr. Manuel is not an advocate of hollow shafts, and though he gathers countenance for his views to some extent from the fact that hollow shafts are not general in the mercantile marine, we do not think the reasons he puts forward would meet with the support of many naval engineers. The paper was, however, full of information, and was followed by an interesting discussion.

Mr. Sydney S. Barnaby followed with an excellent paper, in which he gave a lucid explanation of the theory of cavitation with screw propellers, that new disease which is the outcome of modern high speeds, and to which marine engineers are now turning their attention. We commend Mr. Barnaby's paper to all naval architects who have not mastered this somewhat intricate subject. The last paper read was contributed by Dr. H. S. Hele-Shaw, Professor of Engineering at Victoria University, Liverpool. Its title was "Experiments on the nature of surface resistance in pipes and on ships." This was a most interesting contribution, and might with advantage have occupied more time than could be allotted to it. Doubtless, however, the experiments shown will be brought forward again in other guise. The author's method of studying resistance is to inject water between plates of glass, placing such obstructions to the flow as may be desired, and to throw the image on the screen by the lantern. In order to get a visible result of the streams and eddies, air is injected into the water, or sometimes a coloured liquid. The result is most satisfactory, and cannot but lead to considerable light being thrown on this interesting and very debatable subject. It would be impossible to follow the author in the details of his paper without the aid of graphic representations; but the effects produced on the screen were mostly illustrated by engravings taken from photographs, and presented with the paper. It is to be hoped Dr. Hele-Shaw will carry his work further, and, by their aid, give substantial guidance in this field of research.

The foreign delegates and some of the home members of the Institution continued the work of the congress by visiting Glasgow and Newcastle, where a few of the most prominent shipyards—Fairfield, Denny's, and Elswick—were visited.

LIGHTHOUSE PROGRESS, 1887–1897.

IN 1887 some account was given in NATURE of lighthouse work and progress in the United Kingdom during the preceding fifty years. I propose in this article to consider briefly the same subject in connection with the past ten years, so that the whole may form a summary record of what has been attained during the Victorian era in this important branch of optical and mechanical science.

And, first, it may be asserted that the period of the Queen's reign, distinguished as it is for so many developments of new industries, can boast of none more valuable or more interesting than this now in question. Fresnel's monumental invention in 1819 of the dioptric system of lights was at once welcomed and realised by the French Government, who have since always encouraged and supported the native constructors of lenticular apparatus. But it was only after thirty years from this date that the lighthouse industry was planted in England, if we except the experimental attempts of Messrs. Cookson, of Newcastle. The systematic and permanent establishment is due to the public spirit and the enterprise of Messrs. Chance Brothers, subsequently aided by the mathematical talents and personal direction of Mr. James T. Chance, whose services to the Royal Commission on Lights of 1860, as well as to the Trinity House, and whose writings on lighthouse optics are widely known. It is said that great pecuniary loss resulted from the first efforts of Messrs. Chance, but they have gone on steadily and alone to the present day, with little or none of official aid or encouragement, and they are certainly entitled to full credit for having done so much and so well for the coast illumination of their own country and the world.

I adopt the main divisions of the former articles, viz. Towers, Apparatus, Lamps.

There is not much to be noted in regard to the architecture or engineering features of the iron and stone lighthouses erected in Britain during the past ten years. The principal island towers are in the Shetlands, viz. Stroma, Fair Island, and Sule Skerry, which is one of the dangerous reefs known as *skerries* so thickly strewn on the northern and western coasts. These all are the successful works of Messrs. D. and C. Stevenson. The Trinity House has not erected any rock or pile tower since the Round Island in 1887.

Of lightships there have been established two only, which are at the mouth of the Thames to mark the Edinburgh Channel, and, like all the Trinity lightships, they have 21-inch silver-plated reflectors, with the powerful two-wick oil burners of Sir J. Douglass, the flash from one face of the light being equal to 20,000 candles.

To nearly all the light-vessels in our waters sound-signals, chiefly of the siren type, have been added, which are invaluable in the frequent sea fogs that beset our shores, since by a marvellous beneficence of nature—for the proof of it we are chiefly indebted to the researches of Tyndall—fog that quenches light deepens the intensity of sound. The siren is now an indispensable adjunct to our principal land-lights, and a visit to the Isle of May, the St. Catherine's, or Ailsa Craig, would well repay any one desirous of seeing the latest and best arrangements for the production and transmission of its weird and inimitable notes.

Many of our land lights and floating lights have been connected with the main telegraphic system "for life-saving purposes only." There were, at the end of 1896, 27 such stations in England and Wales, 14 in Scotland, and 11 in Ireland. The most suitable places were selected for the observation of passing vessels and for the immediate transmission of reports of casualities to the nearest points available for help. It is by no means an easy work to make a durable telegraphic connection with a lightship, and with all stations the cost is considerable; but the benefit is so marked that this communication, long and urgently demanded, will soon be extended to all other sites on the coast where the advantage is evident, and the difficulty not insurmountable.

Of the new sea lights in the decade under review may be mentioned the Girdleness, the Rattray Head, the Tarbetness, the Stroma, the Scaddon, the Skroo, and the Sule Skerry, all on the Scottish coast; and the Round Island, the St. Catherine's electric, the Spurn Point, and the Withernsea, on the English coast. The characteristics of several older lights of fixed sections have been changed, such as the Whitby, Coquet, Orfordness, Southwold, and Needles, which have been made occulting lights.

To complete the bare statistics of the subject, it may be mentioned that the whole number of lights of all sorts and sizes on the coasts of the United Kingdom on December 31, 1896, according to the Admiralty List, was 1095, an increase of about 200 over the number of ten years ago. Of the 1095 lights, not more than 11 or 12 per cent. may be classed as of sea-power, and 6 or 7 per cent. as lightships. The rest are port, harbour and pier lights, showing a very abundant supply of local signals apart from the great coast signals controlled by the three Lighthouse Boards.

It would seem, indeed, that the programme of coast lighting is almost completed—at least as regards England. A powerful oil light is to be erected by the Trinity House in St. Mary's Isle, on the north-east coast, and two others in Lundy Isle in the Bristol Channel, where also, at Lynmouth, an electric light is proposed. A further improvement in the fine reflector light of Beachy Head is also spoken of. The Northern Commissioners will erect a first-class light at Noup Head, in the Orkneys, and another on the Flannan Islands in the Hebrides. For Ireland no new light appears to be intended for the present; but the improvement of the Fastnet, the most outlying of our lights westward, must soon be taken in hand.

The *lantern* which crowns the tower and protects the apparatus of a land or rock lighthouse has been materially improved in its construction. The perfect lantern is of adequate area to contain the light and accessory parts, and afford convenient space for service. Its diameter for a sea light is rather 14 feet than 12 feet. It is of circular form throughout, having a cast-iron pedestal of sufficient height to carry an inside and an outside gallery for cleaning purposes. The framing is of gun-metal or wrought iron. The half-inch plate-glass of the purest quality, while resisting wind and weather to a great extent, intercepts the least possible light from the lenses. There is provided abundant ventilation to sustain the central lamp, and refresh the keepers. The best contribution of the Trinity House to the structure has been the large cylindric ventilator on the double copper dome, by which the last-named advantage is mainly secured.

Turning to the optical features of the decade, let us see what changes have affected the two main factors of illumination—the fixed light and the revolving light. The ever-increasing number of ships and ports, and the sustained demand for greater and greater speed of vessels, and for sea signals that shall serve more and more to meet all conditions of weather and to discriminate harbours and channels of approach, have stimulated the efforts of lighthouse engineers in the two directions of power and distinctiveness.

The *characteristics* introduced of late years have been confined for the most part to new combinations and periods of group flashes, or of single equal flashes. Mixed lights of fixed and revolving sections, and therefore with unequal degrees of visibility, are no longer in good repute, although, in the French service especially, they are still retained. Colour also is being gradually abandoned for sea lights. For harbour lights, however, it is still freely resorted to, most of all in Northern Europe, as in the Omo light, Baltic Sea, where in one small apparatus there are no fewer than six characteristics with seventeen variations.

Power has been sought—

(1) By the substitution, wherever practicable, of annular for cylindric lenses, or of revolving for fixed sections.

(2) By the longer focal distance and larger condensing surface of these lenses, and by superposing them in vertical series.

(3) By using an illuminant of maximum intensity, whether oil, gas, or electricity.

(4) By certain variations and extensions of the Fresnel refractors, giving a higher coefficient of beam.

(5) By invoking the principle of the full perception of the light from an annular lens moving in rapid rotation with very short intervals between the flashes. This is known as the *feu éclair*.

(6) By rotating an opaque screen around a lamp, or by raising and lowering quickly an opaque cylinder, or by cutting off and relighting of gas in rapid alternation.

Let us consider these in order.

(1) The reasons for the disuse of fixed sea lights, except in the case of marking or intensifying particular sectors, are chiefly their want of power to penetrate to their natural horizon, and the increasing number of bright fixed lights on ships and on shore, which may in certain conditions lead a navigator into danger from the difficulty of distinguishing them from a lighthouse. The flashing light, with its superior power and numerous possible distinctions, is the best safeguard against this.

(2) The hyper-radial lens of 1330 millimetres focal distance, first suggested (as Prof. Tyndall declared) by Mr. John Wigham, and concurrently at least by Mr. Thomas Stevenson, who less fitly termed it hyper-*radiant* (a good name for the ten-wick oil flame, or ten-ring gas flame), has quite justified the expectation of lighthouse engineers as a convenient and powerful instrument admirably adapted to the large burners now employed. This lens, like its predecessor of 920 millimetres radius, is commonly used without catadioptric prisms, as in the Spurn Point light. The disuse of prisms effects a great saving in cost at but an inconsiderable diminution of power where a high vertical angle of refraction is adopted. Yet it must be admitted that this is at the expense of symmetry and elegance. The French light on Cape d'Antifer is a fine example of the hyper-radial system, embracing a full complement of prisms.

There has also been constructed, at Mr. Wigham's suggestion, as an experiment, what he aptly calls a giant lens of 2000 millimetres radius, but it is not yet adopted in practice.

The superposition of lens lights, each with its own burner, is an obvious means of gaining power, and it is remarkable that, although first suggested in 1859, it was not practically utilised with dioptric apparatus until 1872. Whether biform, triform, or quadriform arrangements be resorted to, the advantage of concentrating or reducing the intensity of the beam according to atmospheric variations is inestimable, and the adaptation reflects undoubted credit on Mr. John Wigham, whose polyannular gas-burner on a like plan had been already approved. The triform

Tory Island light, fitted with these burners, and variable in power from 17,500 to 326,500 candles, may be cited in illustration.

(3) The maximum intensity of an illuminant must still be sought in the electric arc. Gas and oil remain substantially equal compared in lamps of the same size and sort, the superior applicability of each being determined by local conditions. In Ireland the Wigham expanding burners give a marked prominence to the gas, which is copiously used in them. In England and Scotland mineral oil is preferred, its quality being carefully maintained at the highest standard. The old disability of this illuminant, the risk of explosion, has been almost nullified by the production of a petroleum whose flashing point is 230°, and long experience has confirmed its great value. On the other hand, the gas called "incandescent" has been introduced, the best form of it being of the Auer-Welsbach type. The brilliancy of this gas is perhaps only second to that of the electric arc, but the perishable character of its accessories exacts great caution in using it, and it has not as yet been employed in any sea light in this country, although it is already so adopted in France. A mixture of oxygen and coal gas, and one of oxygen and oil vapour, which have been tried in street lamps and otherwise, have been recommended for lighthouses, but not hitherto accepted.

Electricity has been, as it were, on its trial since the South Foreland experiments of 1885, and the evidence affecting it is hardly yet complete enough to justify a final verdict. The result established at the South Foreland was that the electric light is the most powerful under all conditions of weather, and has the greatest penetrative intensity in fog. The Committee of the Royal Society, which examined in 1890 this report of the Trinity House, found that the experiments did really justify the results given.

The twelve years that have elapsed since the trials at the South Foreland have on the whole tended to qualify the conclusion as to the penetrative power in fog. Three lights—two of the group-flashing, and one of the single-flashing character—constructed by Messrs. Chance, may be cited on this point. The triple flash of the Tino light (near Spezia) has been unmistakably discerned in rain and fog at a distance of more than twenty miles. On the other hand, the Isle of May light has been invisible in a thick atmosphere not amounting to fog, at a distance of twelve miles, and in a dense fog at half a mile; and the St. Catherine's light was equally invisible to the *Eider* before she grounded on the Atherfield ledges. It has been, indeed, asserted that the St. Catherine's has often been unseen at a quarter of a mile distance.

The truth appears to be that the electric light is very sensitive to atmospheric conditions, which are so many and so various, and that in thick weather it parts with its power in a much greater ratio than does a gas light, or even an oil light. There is a degree of fog which quenches the sun, while the large luminous surfaces of the superposed gas lenses project on the fog a reddish colouration, and the fog itself thus becomes a signal to the mariner when, as it were, in the words of Persius, "Pinguem nebulam vomuere lucernae." It would be most dangerous, however, for the mariner in a fog to approach the coast presuming on this quality of a light in whose vicinity he supposed himself to be. The lead, the anchor, the horn should be his trust till the veil lifts, and the electric beam shines out in full splendour.

There has occurred no important change in the *burners* of sea lights. The Trinity House improved six-wick, or rather five-wick, remains, if not the largest, the best working oil burner, with a power of 800 candles. This is used generally for lights of the first and second order, while the four-wick, with a power of 360, is used for third order lights, and the eight-wick, of 1200 candles, for hyper-radial lights. The lamp is of the "pump" or the "pressure" type, and contains from 10 to 100 gallons of oil. It is probable that, owing to considerations of space and economy, the gravity system may again be resorted to with enlarged reservoirs seated on the lantern-roof. The electric arc is used with carbons of from 15 mm. to 65 mm. diameter, and currents of from 50 to 400 amperes. The incandescent filament is not found equally appropriate. The luminous intensities obtained from the arc range from five to fifty thousand candles. Both direct and alternating machines are employed. The installations at St. Catherine's and the Isle of May are of the most complete character, and do honour to the distinguished engineers of the Trinity House and the Northern Commissioners.

It may be mentioned that for positions difficult of access, lamps having special wicks and reservoirs for oil or gas, capable of burning from ten to thirty days, are now in use, though, of course, these are only available for small isolated lights.

(4) The improvements since 1887 in dioptric lights are few, and, with one exception, are of no striking importance. The great invention of Fresnel, perfected by the beautiful holophotal arrangements of Stevenson, has remained the cardinal principle of all modern lights of the lenticular type. But the inevitable tendency to modify and improve has resulted in several proposals of more or less merit. Mr. Alan Brebner had, in 1882, submitted an ingenious plan for producing vertical and azimuthal condensation by single agency in cases where straight prisms placed outside the main apparatus had been employed to intensify one or more sea sectors. This method, however, has been seldom, if at all, adopted. Again, Mr. Brebner, in 1884, had recommended a plan of dipping a portion of the beam to some intermediate distance between the lighthouse and the horizon to meet the case of a fog which the strongest beam can only very partially penetrate. This, or some analogous plan, has been tried, but has not prevailed. The advantage of withholding from the horizon a substantial part of the beam, and deflecting it anywhere, is extremely doubtful. The depth and direction of a fog are always uncertain elements. The lighthouse may be surrounded by it while the offing is clear, or *vice versâ*. And it would be in equal measure mischievous to encourage the mariner to stand in, looking for a signal which he might never see, or see too late; and to entrust the lightkeeper with the power to deflect the light according to his own judgment. In 1892, Mr. Charles A. Stevenson published in NATURE an account of his spherical and equiangular refractors which remedy a certain loss of emergent light in the Fresnel refractors. In 1894, Mr. Stevenson further developed his design, claiming for it, within practicable limits, an advantage of at least 10 per cent. in increase of light as compared with the Fresnel lens. The improved refractors have been adopted with success in several of the Scottish lighthouses. In 1895 and 1896, Mr. John A. Purves contributed an able mathematical analysis of equiangular prisms and a new form of spherical central lens, called the Inverse Refractor (the facets of the lens turned inwards), to be used in connection with Mr. C. Stevenson's equiangular prisms. Messrs. Chance have raised the Fresnel lens from 57° vertical to 80°, using glass of the same refractive index, and this angle has been adopted by the Trinity House with great advantage.

(5) The one exception referred to in regard to the minor improvements of optical apparatus since 1887 is the "lightning light," an adaptation of serious importance which has attracted the attention of lighthouse engineers in nearly all maritime countries. The shortening of the interval between the flashes of a revolving light, so that the mariner, especially when in a fast liner, may have more speedy cognisance of the signal that guides him, has become a plain necessity, and led to the gradual reduction of the period from 60, 45 and 30 seconds to 20, 15, 10, and even 5 seconds, reducing proportionately the duration of the flash. So far the principle of the *feu éclair* has been approached. But much more than this is demanded. No one has advocated more strenuously than Lord Kelvin, himself a sailor and a benefactor of sailors, the acceleration of revolving lights. No one has laid it down more clearly that one-ninth or one-tenth of a second is sufficient for the eye to receive the full lustre of a lens passing it. Any longer duration is a loss of time, and therefore of intensity. German and French physiologists have confirmed this, and it is the principle on which the *feu éclair* system is based. In its application, then, if for any "order" of light the maximum of power be desired, the largest available lens in vertical and horizontal angle, combined with a totally reflecting mirror and a central flame of adequate dimensions, must be adopted. If two or more lenses be used, singly or grouped, the intensity of each flash is proportionately less, the interval of time, say five seconds, between the single flashes or the groups of flashes, being the same as where there is only one lens. In this manner the greatest intensity and the shortest interval are secured, and the characteristic as presented to the mariner seems theoretically perfect. The first general introduction of the "lightning light" is due to M. Bourdelles, the chief of the French Lighthouse Administration, under whose auspices several lighthouses on the coasts of France have already been endowed with it. In England Messrs. Chance have constructed, in 1895, for Cape Leeuwin, Western Australia, a "bivalve" apparatus of the first order, with an experimental duration of beam of one-fifth of a second,

and they have placed, this year, in the Exhibition of the Imperial Institute a "univalve," or one-lens apparatus, of the third order. Both these lights are on the *feu éclair* system.

Successful as this system appears to be, it should for the present be regarded as on its trial, and as awaiting the collective judgment of mariners on certain points. And meanwhile it should be estimated as supplementing, not displacing, the well-tried forms of apparatus at the disposal of the lighthouse engineer.

A notable adjunct to the new rapidly rotating lights is the mercury-float carriage, by which the effect of weight and friction is largely diminished. Another excellent quality of this arrangement is its suitableness for stations where earthquakes prevail, as it provides an elastic connection between the optical apparatus and the pedestal, instead of the rigid bearings in the older forms of carriage. If the Curaumilla lighthouse in Chili had been fitted with the mercury-float, it is probable that it would not have been wholly ruined by the shock.

(6) The principle of *occultation*—that is, of interrupting the fixed beam of a cylindrical lens of an oil light by a dark shade moving round or over the flame, or in a gas light by cutting off the gas—is acknowledged to be of extreme usefulness, and has been applied to many of the fixed lights of our coasts. It is not that any power is really added to the light, but that the quick alternation of light and dark in various groups or periods imparts a quasi-intensity to the beam, and a valuable set of characteristics for the mariner. The law of contrast has a physiological effect here, as it has in another manner with the *feux éclairs*. It is an extreme example, but it rests on trustworthy evidence, that the occulting light of Ventotene Island, near Naples, which is of the sixth order only, has been seen from a distance of nineteen miles, its normal range being nine miles. Using the words of Cicero with another application, it may be truly said, "Eo magis elucet quo magis occultatur."

Investigations into the amount of light reflected and transmitted by certain kinds of glass—lighthouse glass among the rest—have been most ably conducted by Sir John Conroy, Bart., at Oxford, in 1888. He traversed by newer methods and with surer results the ground of many observers, from Augustin Fresnel to Lord Rayleigh; and he demonstrated that "the values of the transmission-coefficients for light of mean refrangibility show that for 1 centimetre the loss by obstruction amounts to 2·62 per cent. with crown glass, and 1·15 with flint glass." The refractive index of lighthouse glass lying between 1·52 and 1·54, the loss may thus be practically taken as 2½ per cent. for 10 millimetres of thickness.

The intensities of lighthouse apparatus have of late been diligently considered by lighthouse authorities with the view of determining, once for all, the relative values of the six orders of lights, and of the lamps appropriate to them, and also of publishing the results in the Admiralty Light-list. A large amount of uncertainty and misconception seems to have prevailed on this question. M. Allard, in 1876, in a celebrated memoir, gave an elaborate exposition of the whole subject, but his conclusions, always tending to excess, have not been accepted by more recent investigators.

Other estimates, official as well as private, and more or less discordant, have from time to time appeared, both in this country and France. The factors of evaluation, such as radius, lens-surface, vertical section, flame, reduction for losses, &c., have been combined in different ways by different persons, and some of their conclusions must be regarded as merely empirical. But in 1891 and 1892 a serious attempt was made by a committee of the chief engineers of the three Lighthouse Boards to compile an accurate schedule of intensities with photometry as a basis. Taken as a whole, the values arrived at are fairly acceptable, not certainly erring on the side of excess.

But as yet only the lights with oil or gas for illuminants have been determined.

Electricity appears even more difficult to deal with, and no intensities have been assigned officially to any of the electric lights in the British Islands.

Thus it is uncertain whether, for instance, we are to consider the Isle of May as of six millions of candles, or of twenty-six millions, both estimates resting on competent professional authority. The lights on the *feu éclair* system, oil and electric, are obviously less amenable still to formulæ which may give their coefficients of intensity, although French writers do not hesitate to define these, and deduce thirty or forty millions of candles as "ayant la consécration de la pratique."

It is much to be desired that as a sort of sequel to the publication of the intensities of lights—at all events, of the British lights—there should be provided a form for every vessel under the control of the Board of Trade, in which a return should be made of the appearance of every light approached or passed, with statement of the weather, distance, name and character of the light, &c. These returns, duly kept and handed to the Board of Trade on the first opportunity, would gradually constitute an invaluable record of the merits or demerits of our lights, instructive to the engineer, and, through him, beneficial to the mariner. I have repeatedly, but in vain, urged this expedient on the authorities.

The administration of lighthouses in this country has undergone no change in the past decade, nor, indeed, since 1861, when the Royal Commission on Lights recommended that a Central Board should be constituted instead of the quadriform government then, as now, in force, and gave excellent reasons for the recommendation. The further experience of thirty-six years has amply confirmed the earlier conclusions on this subject, and has brought into stronger relief the example of the French Administration. Some slight approach to the desired reconstruction may be indicated in the Report of the Committee of Inquiry on the Mercantile Marine Fund of 1896, paragraph 71, in the following words: "From the evidence brought before us we unanimously recommend the formation of a small committee containing representatives, possessing as far as possible nautical knowledge, of the Trinity House, the Scotch Board and the Irish Board, which should be summoned at least once a year to advise the Board of Trade upon the desirability of all new works, whether in respect of lighthouses, steamers, buoys or signals, together with all renewals, alterations and important repairs."

But however we may regard the system of government of our lighthouses in contrast with the French system, and desire its amelioration, it is impossible to deny that the United Kingdom has during the Victorian era produced men who individually have done fully as much in every part, theoretical and practical, of lighthouse science as have the distinguished men of the sister country. In one group we can point to the names of Faraday, Airy, Thomson and Chance. In another to those of Stevenson, Douglass, Hopkinson and Matthews. In yet another to those of Farrar, Nisbet, Sydney Webb, Trevor, Wharton and Nares.

These men have enriched and illustrated lighthouse mathematics, engineering, optics, mechanics and nautical and general administration, in a manner and with a success to be gratefully remembered in our day, and never to be forgotten in the new developments of the years to come. J. KENWARD.

[*Note.*—I would invite the attention of visitors to the Imperial Institute to the very ingenious and effective illustration of the progress of British coast lights during the past sixty years, by means of two large illuminated maps and a relief plan. This is exhibited by the Trinity House, whose collection of models, lenses, reflectors and burners is also very commendable.—J. K.]

THE LIMITS OF AUDITION.[1]

IN order to be audible, sounds must be restricted to a certain range of pitch. Thus a sound from a hydrogen flame vibrating in a large resonator was inaudible, as being too low in pitch. On the other side, a bird-call, giving about 20,000 vibrations per second, was inaudible, although a sensitive flame readily gave evidence of the vibrations and permitted the wave-length to be measured. Near the limit of hearing the ear is very rapidly fatigued; a sound in the first instance loud enough to be disagreeable, disappearing after a few seconds. A momentary intermission, due, for example, to a rapid passage of the hand past the ear, again allows the sound to be heard.

The magnitude of vibration necessary for audition at a favourable pitch is an important subject for investigation. The earliest estimate is that of Boltzmann. An easy road to a superior limit is to find the amount of energy required to blow a whistle and the distance to which the sound can be heard (*e.g.* one-half a mile). Experiments upon this plan gave for the amplitude 8×10^{-8} cm., a distance which would need to be multiplied 100 times in order to make it visible in any possible microscope. Better results may be obtained by using a

1 Abstract of a lecture delivered at the Royal Institution on April 9, by the Right Hon. Lord Rayleigh, F.R.S

vibrating fork as a source of sound. The energy resident in the fork at any time may be deduced from the amplitude as observed under a microscope. From this the rate at which energy is emitted follows when we know the rate at which the vibrations of the fork die down (say to one-half). In this way the distance of audibility may be reduced to 30 metres, and the results are less liable to be disturbed by atmospheric irregularities. If s be the proportional condensation in the waves which are just capable of exciting audition, the results may be expressed :—

c'	frequency = 256	$s = 6{\cdot}0 \times 10^{-9}$
g'	,, = 384	$s = 4{\cdot}6 \times 10^{-9}$
c''	,, = 512	$s = 4{\cdot}6 \times 10^{-9}$

showing that the ear is capable of recognising vibrations which involve far less changes of pressure than the total pressure outstanding in our highest vacua.

In such experiments the whole energy emitted is very small, and contrasts strangely with the 60 horse-power thrown into the fog-signals of the Trinity House. If we calculate according to the law of inverse squares how far a sound absorbing 60 horse-power should be audible, the answer is 2700 kilometres ! The conclusion plainly follows that there is some important source of loss beyond the mere diffusion over a larger surface. Many years ago Sir George Stokes calculated the effect of radiation upon the propagation of sound. His conclusion may be thus stated. The amplitude of sound propagated in plane waves would fall to half its value in six times the interval of time occupied by a mass of air heated above its surroundings in cooling through half the excess of temperature. There appear to be no data by which the latter interval can be fixed with any approach to precision; but if we take it at one minute, the conclusion is that sound would be propagated for six minutes, or travel over about seventy miles, without very serious loss from this cause.

The real reason for the falling off at great distances is doubtless to be found principally in atmospheric refraction due to variation of temperature, and of wind, with height. In a normal state of things the air is cooler overhead, sound is propagated more slowly, and a wave is tilted up so as to pass over the head of an observer at a distance. [Illustrated by a model.] The theory of these effects has been given by Stokes and Reynolds, and their application to the explanation of the vagaries of fog-signals by Henry. Progress would be promoted by a better knowledge of what is passing in the atmosphere over our heads.

The lecture concluded with an account of the observations of Preyer upon the delicacy of pitch perception, and of the results of Kohlrausch upon the estimation of pitch when the total number of vibrations is small. In illustration of the latter subject an experiment (after Lodge) was shown, in which the sound was due to the oscillating discharge of a Leyden battery through coils of insulated wire. Observation of the spark proved that the total number of (aerial) vibrations was four or five. The effect upon the pitch of moving one of the coils so as to vary the self-induction was very apparent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG other bequests, the late Mrs. Muspratt, widow of Dr. Sheridan Muspratt, left by will the sum of 500*l.* to University College, Liverpool.

DR. E. S. MACBRIDE, Fellow of St. John's College, and Demonstrator in Animal Morphology in the University of Cambridge, has been appointed to the newly-founded chair of Zoology in the McGill University, Montreal, Canada.

THE University of Leipzig has conferred the honorary degree of doctor of medicine upon Dr. Simon Schwendener, professor of botany at Berlin ; Dr. W. Hempel, professor of chemistry at Leipzig ; and Dr. W. Hittorf, professor of physics in the Münster Academy. The same University has conferred the honorary degree of doctor of philosophy upon Dr. A. Fick, professor of physiology at Würzburg ; Dr. W. His, professor of anatomy at Leipzig ; and Dr. K. von Leibermeister, professor of anatomy at Tübingen.

WE learn from the *Lancet* that Prof. Engelman, in taking over the late Dr. du Bois Reymond's chair of Physiology at Berlin, is arranging certain changes in the Physiological Institute and its four departments. The first, for microscopical and biological work, will remain under the charge of Prof. Fritsch. Similarly, the second, for chemical physiology, will continue under its present director, Prof. Thierfelder. The third, for special physiology, will be greatly enlarged, and the professor himself will take part in its work in conjunction with the present director, Dr. Immanuel Munk. The fourth department, for physical physiology, will also be largely increased ; it will be called the Department for the Physiology of the Sensory Organs, and will remain under the direction of Prof. König. In addition to extensive new buildings, the supply of apparatus will be largely augmented. The lectures will be given by the professor in a course running through two semesters, but during the last four weeks in the summer Prof. König will lecture on the sensory organs, and during the first four weeks of the winter Prof. Thierfelder will lecture on physiological chemistry.

SCIENTIFIC SERIALS.

American Journal of Science, July.—Pressure coefficient of mercury resistance, by A. de Forest Palmer, jun. By means of Barus's screw compressor, a thread of mercury was subjected to a series of pressures up to 2000 atmospheres. If R is the resistance under any pressure, R_0 that under atmospheric pressure, P the pressure, and β the increment for one atmosphere, then $R = R_0 (1 + \beta P)$. The result of the measurements is that $\beta = -0{\cdot}0000332 - 5 \times 10^{-9}t$. This differs only very slightly from the value obtained by Barus.—An interesting case of contact metamorphism, by H. W. Fairbanks. Black Mountain is the highest peak of the El Paso range, a spur of the Sierra Nevada mountains extending eastwards into the Mojave desert. The mountain owes its name to the dark lava which covers it. The underlying rocks constitute a part of an extensive series of sedimentary beds exposed for many miles along the northern slope of the El Paso range. The strata have been considerably disturbed and faulted, and in one of the cañons have been intruded by two dykes. One of these is 14 feet across, and is a holocrystalline olivine diabase. The adjoining rock has been strikingly metamorphosed. The thickness of the band of altered tufa is about 2 feet where it is best exposed. The light-coloured soft rock has been baked to a dark, hard and very firm one, the slabs of which give forth a ringing sound when struck. The layer is not massive, but breaks up into slate-like slabs. The partings are probably due to contraction on cooling.—The tin deposits of Temescal, South California, by H. W. Fairbanks. The tin deposits lie nearly in the centre of a rudely semicircular area of granite, which is fissured along almost innumerable lines in which a black vein matter is deposited. The veins vary from one-fourth to a few inches in thickness, and consist of tourmaline and quartz, with which the tin ores are loosely associated. They occur in two forms : the common variety is either massive and brownish, or in clear reddish-brown crystals lining cavities ; the less common variety is that of "wood tin," which appears uncrystallised and in the form of thin layers.—Electrosynthesis, by W. G. Mixter. Mixtures of various gases were subjected to a feeble alternate discharge in a special form of eudiometer, in which the terminals consisted of glass surfaces holding water on the other side. Under these circumstances, dry carbonic oxide and oxygen slowly combine. Ethylene and oxygen are partly converted into carbon dioxide and water. Acetylene and oxygen are wholly converted into the same. The molecular changes are analogous to those occurring in synthesis effected by heat or light where combination takes place at a temperature far below that at which the gaseous molecules dissociate.

THE *Rendiconti del Reale Istituto Lombardo*, which is devoted to both literary and scientific subjects, contains in recent numbers the following papers of physical interest :—Prof. Aurelio Mauri (xxx., vii.) describes a new potentiometer, and gives an account of observations of the electromotive forces of Clark's cell, and of a new form of element involving the use of acetate of mercury and acetate of zinc. In the next number (xxx., viii.) he gives tables of the electromotive forces of elements involving various salts. In a later number (xxx., x.) Prof. Paolo Cantoni describes certain phenomena connected with the charging of a condenser, and which on starting or stopping the electromotor give rise to sudden repulsions of the plates from the intervening dielectric, followed by attraction. These phenomena, the author considers, are the outcome of temporary

polarisation of the dielectric by induction, followed by permanent polarisation by conduction.—Dr. Giuseppe Bardelli (xxx. xii.) gives a short mathematical note on certain simple relations between centres of gravity and moments of inertia.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 3.—The reptile fauna of Europe, by Dr. J. Bedriaga. Part 2. *Urodela* (continued). A further instalment of this important work, in German, is given.—On the means of obtaining cells without a nucleus, by J. J. Gerasimoff (in German). Having previously obtained such cells by keeping cells of *Spirogyra*, *Sirogonium* and *Zygnema* at a temperature below zero during the process of bi-partition, the author now obtained the same results by means of chloral hydrate, æther, and chloroform.—The histology of the skin of *Petromyzon*, by W. Kapelkin (in German, with two plates).—On changes taking place in the nerve-system and the inner organs after the resection of *Nervus vagus* and *Nervus splanchnicus*, by Dr. W. Niedzvietzky (in German, with four plates). Parts of the *vagus* nerve (about one inch long) were cut out in four rabbits, and of the *Nervus splanchnicus* in two dogs. The animals supported the operations very well, and seven, eight and nine months after the operation they were killed. The author now gives the anatomical changes which were observed, especially in the nerve-system of these rabbits.—Remarks relative to a paper printed by the author in the *Archiv für Psychiatrie*, by Mme. Olga Leonova (in German).

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 5.—The Hon. Lord McLaren in the chair.—Mr. Thomas Heath read a note on the Calcutta earthquake (June 12, 1897), as recorded by the bifilar pendulum at the Edinburgh Royal Observatory. His results have been already communicated to NATURE (June 24, p. 174). He described the instrument as set up on Blackford Hill, and exhibited a model. Vibrations of a transient character due to shocks in or near the building were damped out by immersing the pendulum in the clearest paraffin oil. According to a rough calculation the seismic disturbance on the 12th took twenty-two minutes to travel 4970 miles in a great circle. There were absolutely no premonitory disturbances on the day of the earthquake, but there were indications of continued activity till the 16th. Reference was made to the services this instrument might render in "laying" a certain notorious ghost.—Prof. Tait briefly described the contents of a paper by Lord Kelvin and Dr. Magnus Maclean on leakage from electrified metal plates placed above and below uninsulated flames. The most important result—and an anomalous one apparently—was that the amount of discharge under a flame was much greater when the body ended in a plate than when it ended in a point.—In a paper on the antivenomous properties of the bile of serpents and other animals, and an explanation of the insusceptibility of animals to the poisonous action of venom introduced into the stomach, Prof. Fraser described the steps taken to isolate the constituent of the bile of serpents and other animals that render the venom harmless, and described various experiments on rabbits and white rats illustrating its use.—On the influence of excessive muscular work on the metabolism, by Drs. Dunlop, Noël Paton, Stockman and Mr. Ivison Macadam.—Dr. Gregg Wilson read a paper on the development of the Müllerian ducts of reptiles. In embryo reptiles the first foundation of the Müllerian ducts is a thickened plate of epithelium on the region of the excretory system that has been identified as pronephros. Growth backwards is quite independent both of the segmental duct and of the cœlomic epithelium posterior to the pronephric thickening. There is an anterior ventral extension of the foundation, comparable to the anterior part of the duct in elasmobranchs and to the temporary ventral extension of the Müllerian duct foundation in Rana.—Mr. J. A. Macdonald read a paper on the C discriminant as an envelope. The purpose of the paper was to find the conditions under which the discriminant of the equation

$$U = Ac^n + Bc^{n-1} + Dc^{n-2} + \ldots + Nc^2 + Pc + Q = 0$$

where A, B, &c. are synectic functions of x and y, and c is a parameter, yields a curve which at every point of its length is touched by one of the curves of the system $U = 0$.

Scottish Meteorological Society, July 19.—Extreme variation of the surface temperature of the ocean for every two degrees square, by Dr. John Murray, F.R.S.—Hourly variation of the rainfall at Ben Nevis and Fort-William Observatories, by R. T. Omond.—Some striking peculiarities of the weather of June last, by R. C. Mossman.—Exhibition of a convenient apparatus for the determination of the temperature of saturated steam in connection with barometric pressure, by J. Y. Buchanan, F.R.S.

MANCHESTER.

Literary and Philosophical Society, July 2.—Dr. Edward Schunck, F.R.S., in the chair.—The meeting was held for the presentation of the Wilde medals, and the delivery of the Wilde lecture. The Wilde medal for 1896 was awarded to Sir George Gabriel Stokes "for his pre-eminent services to mathematical and physical science, and in regard of the standing which he occupies in relation to the leading physicists of this and other countries." The Wilde medal for 1897 was awarded to Sir William Huggins "for his researches on the application of spectrum analysis to solar and stellar physics." The state of Sir William Huggins' health unfortunately prevented him from receiving the medal in person.—The premium, under the Wilde Trust, for 1897 was awarded to Mr. Peter Cameron for his papers, published by the Society, on Hymenoptera Orientalia.—Sir George Stokes then delivered the Wilde lecture on "The Nature of the Röntgen Rays."

PARIS.

Academy of Sciences, July 12.—M. de Chatin in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Steenstrup, Correspondant in the Section of Anatomy and Zoology.—Approximate theory of the passage from a gradually varied to a rapidly varied state, or *vice versâ*, by M. J. Boussinesq.—On the employment of copper salts in the estimation of several elements in cast iron and steel, by MM. Ad. Carnot and Goutal. A modification of the cupric ammonium chloride method for the estimation of carbon in steel is described, which permits of a complete determination in less than two hours. Sulphur may be determined by a similar method with equally satisfactory results. In the residue, the chromium, tungsten, and titanium may be estimated.—M. Gayon was elected Correspondant in the Section of Rural Economy, in the place of M. Hellriegel.—Treatment of psoriasis by intra-muscular injections of orchitine, by M. F. Bouffé.—Researches on the ostioles, by M. J. J. Andeer.—On the actual state of the geodesic work in Russian Turkestan, by M. Venukoff.—Observations on the periodical comet of D'Arrest, made at the Observatory of Toulouse with the large Gautier telescope and the Brunner equatorial, by M. F. Rossard.—Observations on the same comet, made at the Observatory of Algiers, by MM. Rambaud and Sy.—On the linear differential equations belonging to the Riemann class, by M. F. Marotte.—Magnetarium designed to reproduce the phenomena of terrestrial magnetism and the secular changes of the horizontal and vertical components, by M. Wilde.—On the absorption of light by crystals, by M. V. Agafonoff.—On a standard thermal mercury voltmeter, and on some applications of the calorimetric method in electric measurements, by M. Charles Camichel. The indications of the instrument are given by the expansion of column of mercury, about one metre long, after the current has been passing for a known interval of time.—A new optical method of studying alternating currents, by MM. H. Abraham and H. Buisson. The rotation produced by the current in a concentrated solution of an alkaline iodomercurate is not directly measured as in the method of Pionchon, but is reduced to zero by applying a second bobbin carrying a continuous current capable of being directly measured. In the curve thus obtained the positive and negative parts are not found to be exactly symmetrical.—Physiological action of the galvanic current, by M. Dubois.—Electrical influence by Crookes' tubes, by M. Foveau de Courmelles.—On the complexity of the bundle of X-rays, by MM. A. Imbert and H. Bertin-Sans. After prolonged use, a Crookes' tube emits rays which appear to differ from the X-rays at first produced, inasmuch as they are able to traverse bodies relatively opaque to the X-rays without appreciable absorption.—On mercury pumps without taps, by M. Chabaud. The mercury pump described in a recent note by M. Henriet (see p. 263), is not new; neither does it present any advantage over the form with valve.—On some basic salts of copper, and on the brown hydrate of copper, by

M. Paul Sabatier.—On the reduction of molybdic anhydride by hydrogen, and on the preparation of pure molybdenum, by M. M. Guichard. The reduction may be completed at 500° C. if the reaction is sufficiently prolonged. The experiments afford no evidence of the existence of any oxides of molybdenum, but MoO_3 and MoO_2.—Action of benzoyl chloride upon the mono-substituted derivatives of the orthodiamines, by M. Fernand Muttelet. In the cold, and in presence of a solvent, a benzoyl derivative is obtained, but at 220°, in presence of an excess of benzoyl chloride, an internal anhydride is formed.—On the formation of mixed hydrates of acetylene and some other gases, by MM. de Forcrand and Sully Thomas. A description of a crystallised compound of acetylene, carbon tetrachloride and water.—Action of sulphuric acid upon lævorotatory terebenthene, by MM. G. Bouchardat and J. Lafont.—Development of aromatic principles by alcoholic fermentation in presence of certain leaves, by M. Georges Jacquemin.—On a new hydrolytic enzyme, caroubinase, by M. J. Effront.—The optical analysis of urine, by M. Frédéric Landolph.—Composition of haricots, lentils, and peas, by M. Balland.—Physiological action of the venom of the Japanese salamander (*Sieboldia maxima*). Attenuation by heat, and vaccination of the frog against the poison, by M. C. Phisalix.—Trophic troubles, resulting from the section of the cervical sympathetic, by MM. J. P. Morat and M. Doyon.—The centrifugal elements of the posterior medullary roots, by MM. J. P. Morat and C. Bonne.—Perforated muscle of the hand. Its appearance in the animal series, by M. A. Perrin.—On two new types of Crustaceæ (Isopods) belonging to the subterranean fauna of the Cévennes, by M. A. Dollfus.—Remarks on the sense organs of the *Sphæromides Raymondi*, *Stenasellus virei*, and of some Ascellidæ, by M. Arm. Viré.—On the defence of vines against the attacks of Cochylis, by M. P. Cazeneuve.——Remark on the subject of the methods of destruction of Cochylis in the vine, by M. Émile Blanchard.—On the tubercles of Orchidaceæ, by M. Leclerc du Sablon.—On the replacement of the principal root by a radical in Dicotyledons, by M. Boirivant.

ST. LOUIS.

Academy of Science, June 7.—Mr. Robert Combs, of Ames, Iowa, presented a paper entitled "Plants collected in the District of Cienfuegos, Province of Santa Clara, Cuba, in 1895–96." The paper embraces the results of a collection extending from the commencement of the rainy season of one year until the close of the dry season the following spring, the territory covered by the collection lying between the entrance of the bay of Cienfuegos, on the south coast of Cuba, up the bay and the river Damuji to Rodas, and extending back from the river to Yaguaramos, and almost to the Cienega de Zapato, a region including nearly all kinds of soil and condition found upon the island, except those of the mountain regions and the mud swamps. A brief statement was made concerning the origin of the Cuban flora, and its affinities with that of continental Central America, rather than the geographically nearer Floridan region. The paper comprised a full catalogue of the collections made, which had been determined at the herbarium of Harvard University, and of which several sets had been distributed to the larger herbaria.—Prof. F. E. Nipher made some remarks on the difficulties yet involved in the theories of the ether.

NEW SOUTH WALES.

Royal Society, June 2.—The President, Mr. Henry Deane, in the chair.—A contribution to the study of oxygen at low pressures, by Prof. R. Threlfall and Florence Martin. There is known to be a pressure (about 0·7 mm. of mercury) at which oxygen becomes unstable in its volumes and pressure relations. This instability may plausibly be attributed to a change in the chemical nature of the gas, and during the period of change it is possible that ozone may be temporarily produced. An experiment was made with the object of investigating whether oxygen can form ozone simply by virtue of a reduction of pressure. A suitable indicator having been discovered, an experiment was satisfactorily carried out showing either that no ozone at all is formed when the pressure falls to from 0·4 to 0·1 mm., or that, if such formation does occur, it is to an extent less than 0·005 per cent. of the volume of the gas employed.—Determination of the orbit elements of comet of 1896 (Perrine), by C. J. Merfield. The author explained that his deductions were based on observations made in various American and European observatories, and also on observations made by Mr. John Tebbutt, of Windsor, New South Wales. The elements as determined by him agreed substantially with those determined by Dr. Knopf, and would not, in his opinion, be sensibly varied by further investigations.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section), Part 1 for 1897, contains the following memoirs presented to the Society.

January 9.—P. Stäckel: Extracts from the correspondence of Gauss with W. Bolyai. R. Müller: Approximately rectilinear motion by means of the jointed quadrilateral. W. Schur: The polar flattening of the planet Mars.

February 6.—W. Voigt: The kinetic theory of ideal fluids.

February 20.—D. Hilbert: Diophantine equations. A. Wirnau: The substitution-groups of eight things.

March 6.—D. Hilbert: On the development of a given analytical function of one variable as an infinite series of rational integral functions. A. Hurwitz: On the generation of invariants by integration.

The accompanying *Geschäftliche Mittheilungen* include a memoir of Karl Weierstrass by David Hilbert, of Ernst Curtius by F. Leo, and of August Kekulé by Otto Wallach.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Voyages made by the Sieur D. B. to the Islands Dauphine or Madagascar, &c.: translated and edited by Captain P. Oliver (Nutt).—Elemente der Geologie: Dr. H. Credner, Achte Auflage (Leipzig, Engelmann).—Fifteenth Annual Report of the Fishery Board for Scotland, Part 3 (Edinburgh)—Wild Flowers of Scotland: J. H. Crawford (Macqueen)—The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies: Dr. E. J. Routh, 6th edition (Macmillan).—Introductory Course in Differential Equations: Dr. D. A. Murray (Longmans).—Modern Mythology: Andrew Lang (Longmans).—Our Coal Resources at the Close of the Nineteenth Century: Dr. E. Hull (Spon).—Ludwig Otto Hesse's Gesammelte Werke (München, K. Akademie).—The Ascent of Man: H. Drummond, new edition (Hodder).—Among British Birds in their Nesting Haunts: O. A. J. Lee, part v. (Edinburgh, Douglas).

PAMPHLETS.—Effects of the Weather upon Vegetation: J. Clayton (Bradford, Byles).—Nel Paese della Amazzoni: Dr. V. Grossi (Roma).

SERIALS.—Proceedings of the Physical Society of London, Vol. xv. Part 7 (Taylor).—Quarterly Review, July (Murray).—Terrestrial Magnetism, June (Wesley).—Engineering Magazine, July (Tucker).—Proceedings of the Royal Society of Queensland, Vol. xii. (Brisbane)—Journal and Proceedings of the Royal Society of New South Wales for 1896 (Sydney).

CONTENTS.

THURSDAY, JULY 29, 1897.

M. FAYE ON CYCLONES.

Nouvelle étude sur les Tempêtes, Cyclones, Trombes ou Tornados. Par M. Faye, Membre de l'Institut et du Bureau des Longitudes. Pp. vii + 142. (Paris: Gauthier-Villars et fils, 1897.)

M. FAYE has quitted the position of dignified retirement to which he is entitled by his age and his scientific reputation, to do battle with the meteorologists. For the last twenty-five years, as he reminds us, he has struggled to ensure the recognition of his views concerning the origin and development of cyclones and tornados. At the advanced age of eighty-three, he again enters the arena of polemics and controversy, hoping to secure converts and supporters of the views that he has consistently held. We may offer our congratulations to the distinguished physicist on the vigour which such an undertaking demonstrates, but we could have wished that it had been exhibited in a manner better qualified to justify his reputation, and increase the number of his admirers. In the work which M. Faye has undertaken, of collecting his scattered writings and systematising the information which supports his views, he is perhaps supported by the belief that his theory is making headway. He quotes the remark of M. Sainte-Claire Deville, who, in the Academy, asserted with some warmth that M. Faye was entirely alone in his opinion, that there was not a meteorologist, not a sailor, who shared his views, and at that time the author admits that he was universally condemned, but adds, "If I were put on my rial to-day I should get some votes, though not enough o acquit me." In this opinion we think M. Faye deceives himself—the views of American and German meteorologists are as much opposed to those he holds as when M. Deville made his cutting rejoinder.

The interest which M. Faye takes in meteorology in general, and in cyclones in particular, is the outcome of the attentive study which he has given to the behaviour of sun-spots. As is well known, he is the author of a theory concerning the origin of these phenomena which was respectfully received at the time it was enunciated, and gained some adherents, but accumulated knowledge drawn either from spectroscopic or photographic observations has done nothing to support it, and probably the hypothesis would now find fewer partisans than when originally conceived. M. Faye tells us that these spots are due to downward gyrating movements produced in the currents that everywhere furrow the photosphere, and carrying with them the cooler gases of the solar atmosphere. Fully possessed with the accuracy of this notion, it is easy for him to pass to terrestrial cyclones, and to see the same mechanism operating in our atmosphere. His judgment seems to be warped by his preconceived theories, and he views a cyclone or a tornado as originating in the upper strata of the atmosphere and penetrating downwards to the earth's surface. Herein lies the fundamental difference between the theories of M. Faye and those of modern physicists. The unanimous opinion of meteorologists, he is forced to admit, is that our cyclones are not the result of downward, but of an ascending motion. The evidence that is sufficient to convince most inquirers leaves M. Faye in doubt. While all the observed phenomena of a cyclone are not fully explained, there is still room for an alternative theory. M. Faye quotes with approval Dr. Sprung's admission that the motion of translation of cyclones is not adequately explained by any accepted theory. Like a practised controversialist, he knows how to make the most of such difficulties.

"Je disais aux météorologistes : Vous cherchez en bas, au sein d'un air calme, ce qui ne peut s'y trouver : la cause de cet effroyable mouvement ? Eh bien ! levez les yeux, et voyez quels mouvements rapides existent dans les hauteurs de l'atmosphère à 2000^{m} seulement, où les couches d'air se transportent à grande vitesse sans que nous en sentions rien en bas ; c'est là qu'il faut chercher ; c'est là et non au ras du sol, qu'il faut placer l'origine du phénomène. Mais alors il faut renoncer aux trombes ascendantes, il faut reconnaître que les mouvements d'ensemble sont descendants."

Meteorologists would probably give M. Faye his 2000 metres, or something like it. The greater the saturation of the air the easier would the ascending current be maintained, and the greatest saturation would probably occur near the lowest cloud stratum. The origin of the tornado or the cyclone would probably not be "au ras du sol," but at some distance from the surface. But in the "drift" theory of translation M. Faye has no original rights. Ferrel and Loomis have equally asserted the principle of the "drift" theory, and it is difficult to see what support it lends to the "downward" motion or advances our knowledge of either the origin or the motion of cyclonic centres.

The real question at issue, and one which it would seem might be settled by observation, is one of fact. Is there an indraught of air to the cyclone vortex at or near the earth's surface and a consequent ascending current over it, or, on the other hand, an outflow from a descending current? Or, to adopt the characteristics and nomenclature with which the author sums up the discussion on tornados, and contrasts his theory with those of meteorologists, we may arrange the question thus :—

M. Faye.

Aspiration	...	nulle.
Ascension	...	neant, l'air de la trombe est descendant par sa trompe.

Meteorologists.

Aspiration	...	énergique, en masses énormes.
Ascension	...	totale, couches inférieures portées en haut.

The two theories are the reverse of each other ; we cannot say with the author that the meteorological theory is the reverse (contrepied) of the truth. Observation, as mentioned above, ought to be able to settle this question, and consequently a large portion of M. Faye's book is occupied with accounts of cyclones and tornados, drawn from various sources from the time of Dampier to the present day. And the author, as we think, lingers rather lovingly over the older sources of information. His sympathies and his admiration centre round Redfield and Piddington rather than Ferrel and Loomis and Blandford. We doubt if the last-named occurs once in

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the whole book. We gather, too, that Faye himself has never witnessed the destruction caused by the passage of a severe tornado. He has to rely entirely on the accuracy of eye-witnesses, to picture the scene as best he can, to select his facts, and to supply the explanations that best accord with his notions. This places him at a disadvantage when compared with some other of the physicists named. M. Faye is of course obliged to admit that heavy objects are sometimes carried to a distance. He sees these objects practically whisked over the surface by a succession of impulses, like a football continually kicked in the same direction. That some of these objects, transported possibly for miles, are often of a frail nature, and would be broken by rude and frequent contact with the surface, is not remembered. But if M. Faye had actually witnessed these occurrences, he could not have treated the evidence so lightly.

Then the author avails himself of another mode of escape. When the evidence in favour of an ascensional current is too strong, then the phenomena of which it is a characteristic is not that which is under consideration. Consequently we have "fausses trombes" and "pretendus cyclones" whose explanation, as generally given, the author would accept but without admitting any similarity with the more powerful manifestations. Something of disdain runs through the following passage :—

"On cite même des trombes de linge exposé sur le sol pour sécher, où l'on voit le linge, les mouchoirs, les chemises, &c., s'élever dans les airs en tournoyant pour retomber plus tard au loin sur le sol . . . ce sont de fausses trombes dont on a fait la théorie d'ailleurs parfaitement correcte."

As a general rule it is a matter of perfect indifference to the ordinary purposes of life whether we hold a correct or an incorrect theory in astronomy or meteorology. Life and commerce and navigation would go on the same whether we believed that the earth went round the sun or the sun round the earth. But in this matter of tempests and cyclones, trade and commerce can be very adversely affected if we teach an incorrect theory of their origin and motion. A captain can only hope to escape from the danger with which they threaten him by localising with some precision the situation of the inner vortex. To do this he has but one guide, the direction of the wind. The use he makes of this guide in inferring the position of the ship with reference to that of the storm centre will be materially affected by the views he holds concerning the motion of the wind in a cyclonic storm. A rule must be devised for his guidance without ambiguity, and one that can be followed without hesitation. Piddington and the older meteorologists held that the movement of the wind in a cyclone was circular. In this view they are followed by M. Faye. The result of this belief was the enunciation of the rule of eight points, expressed something in this way. With the face turned to the wind extend the right arm. In the northern hemisphere you will point in the direction of the storm centre. This rule can be supported only by ignoring a great mass of recent observations. The rule asserts that the wind blows at right angles to the radius, but it has been shown, over and over again, that in true cyclones the winds are strongly inclined inwards; not directly to the centre, but approaching it by a spiral. A more accurate rule has been deduced and is supported by weighty authorities, but not by M. Faye. In the northern hemisphere with face to the wind, the direction of the centre is from ten to eleven points to the right-hand side. To go back to the old rule of Piddington is a retrograde step, but the mischief does not end there. The distrust likely to be awakened in the mind of the seaman by the spectacle of disaccord among scientific authorities can have the most disastrous results. The ordinary seaman asks for a clear and precise rule, on which he can act without argument or question, while his whole attention is directed to the preservation of his ship. M. Faye is a great authority. His name is one to conjure with, and it is not unlikely that the rules which he quotes with approval will be copied into English books by those who compile manuals of brief and ready directions for navigation, and in this way perpetuate an evil against which a mass of scientific evidence, collected in less accessible quarters, is powerless.

THE YEW.

The Yew-Trees of Great Britain and Ireland. By John Lowe, M.D., &c. Pp. xiv + 270. (London: Macmillan and Co., Ltd., 1897.)

NOT far behind the oak stands the yew in popular estimation. Its associations, its form, its distribution, its utility, account for this. We consider it an aboriginal native, and so no doubt it is. From the Tertiary epoch to the present it has been in existence, and now it extends over the whole of the northern hemisphere from Norway to the Azores and Algeria, from Ireland to the Amur. It abounds in certain parts of the Himalayas, and we have it from the ruby mines of Burmah. In Japan a yew exists which it is hard to distinguish from our European species. From Canada to Virginia in Eastern America another species ranges, whilst on the opposite side of the American continent in California and some parts of the "Rockies" yet another is found; one, moreover, is chronicled from the mountains of Mexico. According to circumstances, and especially according to his proclivities, the botanist will range all these as separate species (Parlatore enumerates six), or as representatives of one and the same. The *Index Kewensis* quotes no fewer than ninety synonyms for these six species, a pretty good illustration of the variation among botanists! Those who visit an extensive tree-nursery, and see the large number of forms known to be seedling variations from the common yew, will be inclined to favour the idea that there is but one species. Those whose research is limited to herbaria may come to the opposite conclusion.

Naturally the yew is diœcious, the male flowers being on one tree, the female on another; but it not unfrequently happens that flowers of both sexes may be met with on the same branch. It seems natural to expect a greater amount of variation among diœcious than among monœcious trees; but it is striking to see so much variation in trees growing, as far as we can see, under the same natural environment. There are yews with red fruits and yews with yellow, golden variegations and silver-mottled

leaves, long leaves, short leaves, leaves in two ranks, leaves in spiral arrangement; the latter being probably the primordial disposition, the two-ranked arrangement being more apparent than real. When the stem and branches grow erect, as they do in some varieties, particularly in that called the Irish yew, the leaves are in spiral order, and when the larva of a little fly (*Cecidomyia taxi*) has its abode in the young buds, the degenerated leaves are in spires.

In this country, at least, the yew is not generally found in association with other trees of the same or other species. Woods entirely or mainly composed of the tree are rare. One such we know, and it is duly noted in the book before us: we allude to the very remarkable grove at Cherkley Court, near Leatherhead. Here are some ninety to ninety-five acres covered with yew-trees, to the almost, if not complete, exclusion of everything else. They form a most impressive sight, and still more impressive than their numbers is the variety of their forms, their difference "in habit," as gardeners say. They are all growing under like circumstances, and yet there is this astonishing variation in outward form. There is a similar but much less extensive group at Cliveden, the gnarled roots of which, clinging on to the chalk escarpment for dear life, are very picturesque.

The isolated condition of yew-trees is no doubt due to the trees having been planted where they now are, as in churchyards, or along the roadsides.

If old yews do not exhibit the highest type of arboreal beauty, there are few trees more imposing. This, no doubt, leads to exaggerated estimates of their age. On this subject quite a literature has grown up. Dr. Lowe has a statistical chapter relating to it in the present volume, reprinted from the *Journal* of the Linnean Society; but the results are not uniform, and it is evident that further research on the comparative rate of growth of various trees is to be desired.

In the book before us the author treats the yew from almost every point of view; he has been conscientious in his work, accurate in his statements, careful in the verification of his references—in fact, he has produced a monograph which will be consulted in the future, and which will be read with interest by the lovers of trees at the present day. The book, too, is well printed, well illustrated, and provided with a sufficient index. A few amendments may be suggested—Cliveden is in Bucks, not, as stated, in Berks; the "De Candolle," so often mentioned, was "Augustin Pyramus," not "Alphonse," as might be inferred; *Gardener's Chronicle* should be *Gardeners'*; and the reference "1870–1890" is very inadequate, seeing that the periodical in question dates from 1841, and contains various references to the yew in its earlier as in its later volumes; "Helmsley" should be "Hemsley." Reference to Sargent's "Silva of North America," which contains an epitome of almost all that is known concerning the yew, whether in America or elsewhere, would be desirable in a new edition. We suspect from the date of publication that the author of the "Yew-Trees of Great Britain" could hardly have been able to consult the "Silva." The microscopical structure of the wood and leaves should also receive some attention, as it differs considerably from that of other conifers. Yews, for instance, have no resin canals.

OUR BOOK SHELF.

Untersuchungen ueber Bau Kerntheilung und Bewegung der Diatomeen. Von R. Lauterborn. Mit 1 figur im Text u. 10 Tafeln. (Leipzig: Verl. v. Wilhelm Engelmann, 1896.)

IT is some years since Bütschli declared that centrosomes could be identified during life in certain diatoms, just as Van Beneden had already described them in the segmenting eggs of *Ascaris megalocephala.* But whilst the worm has furnished the text for numberless papers and memoirs, the diatoms have been passed by and left unheeded.

Dr. Lauterborn's book will again direct attention to this neglected group, for the observations he records are so startling in themselves, and so unlike anything else with which we are as yet acquainted, that they will urgently require confirmation at the hands of other investigators.

The author has succeeded in following out many of the details of cell-division in the living cells, and this fact is calculated at once to arrest the attention of cytologists, who are all aware of the great difficulty which exists in making much out of a nucleus till it has been fixed and starved. Perhaps the most remarkable statements in the volume are those which are concerned with the origin and structure of the spindle and its relation to the centrosome. The latter structure is a spherical body lying near a depression in the nucleus, but when karyokinesis is about to begin, a second sphere is seen to lie close to the centrosome, and Lauterborn believes it has been actually derived from the latter. This second body is the rudiment of the central spindle, and it wanders about independently of the centrosome, and becomes rapidly of an elaborately complex nature. Ultimately it is found within the nucleus, whilst the centrosome is left outside. Meanwhile two masses of protoplasm become apparent in an excentric position at the ends of the barrel-shaped spindle, and these are regarded by the author as representing two fresh centrosomes. Finally the chromosomes split, become arrayed on the spindle, and are distributed to the two poles. But even in this process we meet with an anomaly, for there seem to be no mantle fibres formed, or indeed any other special mechanism by which the chromosomes find their way to their destination; they are stated to move automatically to the ends of the spindle. The cell-wall, which divides the diatom into two cells, originates in much the same way as in *Spirogyra*, beginning at the cell periphery and advancing to the centre.

The above sketch will show that these plants, of which *Surirella* has here been taken as a leading type, differ in many respects from other organisms in the mode of their cell-division. But the author by no means confines himself to the topic of karyokinesis. The structure of the protoplasm, and of its varied organised inclusions, as well as the remarkable movements exhibited by the plants themselves, all come in for a share of attention. In short, the book is one which should serve to stir up research into a group of plants which have hitherto been too much regarded as the special property of amateurs who, with the aid of expensive microscopes, delighted to count striæ and to make species.

Journal and Proceedings of the Royal Society of New South Wales for 1896. Vol. xxx. Edited by the Honorary Secretaries. Pp. xxiv + 410 + cxlviii. (London Agents: George Robertson and Co., 1897.)

THE twenty-four papers in this volume testify to scientific activity at the antipodes. In his presidential address Prof. T. W. Edgeworth David sums up the contributions of New South Wales to scientific knowledge during

1896, and discusses the structure and origin of the Blue Mountains of the colony. Mr. H. C. Russell's paper, in which he shows that the good and bad seasons follow a nineteen years' cycle, appears in the volume, with the discussion which took place upon it. Among other subjects and and authors of papers are: The Mika or Kulpi operation of the Australian Aboriginals, by Prof. T. P. Anderson Stuart; the cellular kite, by Mr. Lawrence Hargrave; an explanation of the marked difference of the effects produced by subcutaneous and intravenous injection of the venom of Australian snakes, by Dr. C. J. Martin; recent determinations of the viscosity of water by the efflux method, by Mr. G. H. Knibbs; the occurrence of precious stones in New South Wales, and the deposits in which they are found, by the Rev. J. Milne Curran; the rigorous theory of the determination of the meridian line by altazimuth solar observations, by Mr. G. H. Knibbs; an address to the engineering section of the Society, by Prof. W. H. Warren; the machinery employed for artificial refrigeration and ice-making, by Mr. Norman Selfe; and the present position of the theory of the steam engine, by Mr. S. H. Barraclough.

Many of the papers are accompanied by plates, that of the Rev. J. M. Curran being particularly well illustrated.

L'évolution régressive en biologie et en sociologie. By Jean Demoor, Jean Massart, and Prof. Émile Vandervelde. Pp. 324. (Paris: Félix Alcan, 1897.)

To show that the laws of biology are followed in the domain of sociology has been attempted by many writers. Unfortunately, bio-sociological subjects are often taken up by naturalists who have little knowledge of social questions, or by sociologists having but a superficial acquaintance with biological realities, the result being unsound conclusions and exaggerated analogies. With the view to see the subject from different aspects, and produce a composite picture in which neither sociology nor biology is given undue prominence, the authors of this book have collaborated in its production. The result is not altogether satisfactory, for the book is really more sociological than biological, and not good at that. The general conclusions which the authors labour to prove are that evolution is at once progressive and retrogressive, that transformations of organs and institutions are always accompanied by retrogression, and that the same laws hold good in the changes of societies as well as organisms; all the actual forms undergoing transformation, and, in consequence, losing certain parts of their structure. The text of the book is the universal application of the principle of devolution, and in the exposition of it the authors have exercised their ingenuity to the utmost.

The Geographical Journal. Vol. ix. January to June 1897. Pp. viii + 748. (London: The Royal Geographical Society; Edward Stanford, 1897.)

This volume of the Royal Geographical Society's *Journal* contains several papers of exceptional interest, among them being Mr. W. L. Sclater's final contribution on the geographical distribution of mammals; a paper on the formation of sand-dunes, by Mr. Vaughan Cornish; Sir Martin Conway's account of his Spitsbergen expedition; two years travel in Uganda, Unyoro, and on the Upper Nile, by Lieut. C. F. S. Vandeleur; Dr. Nansen's statement of the results of his arctic expedition, and his views on the north polar problem; and a paper by the president, Sir Clements Markham, on the voyages of John Cabot. In addition to these papers, the monthly record and a number of special articles furnish a store of interesting information on geographical progress in its widest sense. Large coloured maps and other illustrations accompany the papers, and assist in making the volume valuable.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Electro-Chemical Equivalent of Silver.

In NATURE, vol. lvi. p. 259, Mr. Griffiths points out that recent comparisons of the values of the mechanical equivalent of heat, obtained by mechanical and electrical methods, suggest that the adopted value of the equivalent of silver may be in error to the extent of 1/1000. This adopted value rests, I believe, almost entirely upon experiments made by Kohlrausch, and by myself with Mrs. Sidgwick in 1882; and the question has been frequently put to me as to the limits within which it is trustworthy. Such questions are more easily asked than answered, and experience shows that estimates of possible error given by experimenters themselves are usually framed in far too sanguine a spirit.

When our work was undertaken the generally accepted number was ·01136, obtained by Kohlrausch in 1873. Mascart had recently given ·01124, subsequently corrected to ·011156. The uncertainty, therefore, at that time amounted to at least 1 per cent. The experiments of Mrs. Sidgwick and myself were very carefully conducted, and we certainly hoped to have attained an accuracy of 1/2000. So far as errors that can be eliminated by repetition are concerned, this was doubtless the case, as is proved by an examination of our tabular results. But, as every experimenter knows, or ought to know, this class of errors is not really the most dangerous. Security is only to be obtained by coincidence of numbers derived by different methods and by different individuals. It was, therefore, a great satisfaction to find our number (*Phil. Trans.*, 1884) (·011179) confirmed by that of Kohlrausch (·011183), resulting from experiments made at about the same time.

It would, however, in my opinion, be rash to exclude the question of an error of 1/1000. Indeed, I have more than once publicly expressed surprise at the little attention given to this subject in comparison with that lavished upon the ohm. I do not know of any better method of measuring currents absolutely than that followed in 1882, but an ingenious critic would doubtless be able to suggest improvements in details. The only thing that has occurred to me is that perhaps sufficient attention was not given to the change in dimensions that must accompany the heating of the suspended coil when conveying the current of ½ ampere. Recent experiments upon the coil (which exists intact) show that, as judged by resistance, the heating effect due to this current is 2½° C. But it does not appear possible that the expansion of mean radius thence arising could be comparable with 1/1000.

RAYLEIGH.

Terling Place, Witham.

Acetylene for Military Signalling.

In conjunction with Captain J. E. S. Moore, I have been making some experiments on the use of acetylene in signalling lamps. We have obtained such good results with the very primitive apparatus at present employed, the light is so brilliant, and the requirements so portable, that it seems well worth considering whether acetylene could not take the place of the limelight where portability is an object.

The apparatus consists of a 5-oz. bottle, carrying a two-hole rubber cork; water drips on to the carbide from a wide glass tube, holding some 2½ oz., and furnished with a connection of rubber tube and a screw-clamp to act as regulator. The gas escapes from a straight tube to the lamp, being trapped on the way by a wider piece of tube, into which the smaller tubes are corked at either end: this makes a sufficient condenser for any water vapour. The gas tube enters the lamp through the base, and the gas burns from an ordinary 0000 Bray. The generator, when charged, weighs one pound, and after a couple of minutes, during which time the action is a little irregular, will give a steady light for thirty or forty minutes; on more than one occasion, indeed, it has run out without the clamp being touched after first adjustment. We find an ordinary lamp small for the heat produced, and have had to rivet the soldered parts; but increased ventilation would be easy to arrange. Of course for permanent work the generator would have to be arranged in metal; even then it would probably be the lightest gas-supplying arrangement, for the illumination, yet produced.

The Laboratory, Felsted, Essex. A. E. MUNBY.

Disappearance of Nitrates in Mangolds.

DURING last autumn, winter, and spring, I made a series of analyses of mangolds, determining in each case the nitrogen present as albuminoids and as nitrates.

The roots were pulled during the last week in October, and clamped in the ordinary way. Roots of the same weight—about 7 pounds—were taken for analysis on the dates shown in the table.

The albuminoid nitrogen was determined in the dry matter, by leaving two grams in contact with 4 per cent. carbolic acid, containing metaphosphoric acid, for twenty-four hours; the nitrogen determined in the insoluble portion, by Kjeldahl's method, being taken as albuminoid nitrogen.

The total nitrogen was determined by a modification of Kjeldahl's method in the dry matter.

The nitric nitrogen was determined in the juice by Schlœsing's method.

The amide and ammoniacal nitrogen was calculated from the above by difference.

The results are given in the annexed table.

Table of Results of Mangold Analyses.

Date of analysis	Total nitrogen		Albuminoid N.		Nitric nitrogen		Amide and ammon. N.	
	Per cent. in root	Per cent. of total N.	Per cent. in root	Per cent. of total N.	Per cent. in root	Per cent. of total N.	Per cent. in root	Per cent. of total N.
October 12 ..	·183	100	·055	30·0	·050	27·3	—	42·7
December 1 ..	·241	100	·113	48·4	·048	19·8	—	31·8
February 1 ...	·238	100	·075	32·1	·035	14·7	—	53·2
March 10 ...	·207	100	·061	29·3	026	12·6	—	58·1
,, ,, ...	·204	100	·053	25·9	·028	13·5	—	60·6
April 20[1]... ..	·277	100	·047	17·3	·023	8·3	—	74·4
,, ,, ...	·250	100	·062	24·8	·022	8·8	—	66·4
May 20	·233	100	·056	24·0	·022	9·4	—	66·6

[1] This root was rotten inside and hollow.

Two questions appear to me to arise from these analyses:

(1) Is the disappearance of the nitrates due to a denitrifying action of the cells, or to bacterial action?

(2) Is not this disappearance of the nitrates during storage answerable for the fact that mangolds are more suited for food after January than in the autumn?

I purpose repeating these experiments on a larger scale next winter. T. B. WOOD.

Agricultural Department, University of Cambridge.

Globular Lightning.

THE following appears to be an instance of so-called "Globular Lightning" (NATURE, vol. xl. pp. 296, 366, 415, &c.).

During the thunderstorm of July 20, with which the drought broke up, an elderly man, Thomas Smith, residing in this parish about half a mile from the railway station, was watching the lightning from his cottage door, between 5 and 6 p.m., when he noticed a white ball, "about the size of an egg," dancing about in the air "like rooks when at play." He watched it through the intervals between two or three lightning flashes, therefore during several seconds. After some interval (perhaps a few minutes), he still standing at the door, his wife just coming down the stairs to him, something seemed to pass between them which felt hot to their faces. Simultaneously Miss Downes, schoolmistress, sitting on the landing above the stairs, felt something hot pass her hair behind, and then in a small bedroom, with open door adjoining, a loud detonation took place; whitewash from the ceiling covered bed and floor, the wall-paper was torn, the plaster fissured, and the house filled with a "sulphurous" smell.

There is a draught up the stairs, but no apparent reason why what it brought should enter the little bedroom. The cottage stands alone, on high ground, but not the highest, and there is nothing exceptional in its construction or its surroundings.

Cockfield, Suffolk, July 22. E. HILL.

"Bicycles and Tricycles."

IN reading Mr. Boys' most interesting review of Mr. Sharp's book on "Bicycles and Tricyles" (NATURE, July 8), a few points occur to me as requiring further notice.

In Chapter xi., on bending, the *strengths* of tubes of various sections are compared by considering the modulus (Z) of each section, while Mr. Boys speaks of *stiffness*, and mentions that D tubing is 1 per cent *stiffer* than round tube of the same weight and width. I venture to think that, in stating this, Mr. Boys has overlooked the fact that, since the D section is unsymmetrical about the longer axis, the ratio of its moment of inertia to that of round tube $\left(\frac{I_D}{I_0}\right)$ is much greater than the ratio of the moduli $\left(\frac{Z_D}{Z_0}\right)$.

Thus the relative stiffness of D tube $\left(\frac{\cdot 1542}{\cdot 1250} = 1\cdot 23\right)$ is much greater than its relative strength $\left(\frac{\cdot 252}{\cdot 250} = 1\cdot 008\right)$.

These values assume the D section to be semicircular, and the tubes to be infinitely thin; when the thickness is finite, the round tube must have the thicker wall, and the mean diameter becomes less than the mean radius of the semicircle, so that the ratios become greater still.

In practice the semicircular section is seldom used, a much more square-shouldered shape being preferred, which, whilst only slightly less stiff than rectangular tube of the same weight, width and perimeter, is much less unsightly in appearance. The actual advantage of D tube over round is found by experiment to be from 30 per cent. to 40 per cent.

It may be well here to draw attention to tests of various fanciful sections (webbed, corrugated, &c.), which are published from time to time, showing great apparent advantages over plain tubing. In every case the test is made by supporting the tube at the ends, and applying the load at the centre by means of the ordinary knife-edge used for testing solid bars. The result is that the tube wall is crushed in long before the real limit of bending moment is reached, and the test merely indicates resistance to local denting. To avoid this the tube should be as long as possible, and the load distributed over a large area.

Mr. Sharp's book is the first serious effort that has been made to bring the cycle-maker into line with the rest of the engineering profession. R. H. HOUSMAN.

Mason College, Birmingham.

I AM obliged to Mr. Housman for pointing out a slip of expression in my review of Mr. Sharp's book. I had not confused the ratio of the I's for the ratio of the D's, but merely inadvertently used the word "stiffness" in its colloquial and more extended sense, so to include resistance to forces which would seriously bend or damage, as well as to those which would produce infinitesimal bending.

While on the subject of strength or stiffness of thin tubes, it may be worth while to point out that the complete theory of bending, as applied to very thin tubes, is by no means included in the usual formulæ; and it is for this reason that properly designed experiment is essential in extreme cases.

C. V. BOYS.

"A Text-book of Histology."

MY attention has been drawn to a review of my work on histology, which appeared in your issue of May 20; and as the review appears to me to be biassed, and amounts in fact to a public attack on me as an histologist, I trust you will, in fairness, give me the opportunity of as publicly defending myself, by inserting this letter in your next number.

Not one of the charges brought against the book can be fairly substantiated. Your space will not admit of my traversing more than a few of the points raised, but these will serve as samples of the whole.

(1) Your reviewer refers to a well-known excellent atlas of histology, and contrasts the accuracy of the drawings with mine. I deny the justice of his comparison: to take instances, if any one will compare the drawings of the eye and cochlea in my text-book with those of the same structures in the atlas, he will speedily be convinced as to where the inaccuracy lies. If the descriptions in the atlas referred to contained much that was new at the time, I can only say that histology must have

been previously in a very bad pass indeed; but, as far as I know, there is very little that was new even then, except the portion of the work dealing with the lymphatics.

(2) Your reviewer appears not to have apprehended the purpose for which the book was written, viz. to help the ordinary student. To endeavour to teach him how to trace degeneration of nerve fibres "by the invaluable method described by Marchi" is laughingly absurd to any one who has had much acquaintance with histological classes.

(3) Staining in bulk is by no means omitted, the process being carefully described in the chapter on methods, and referred to again and again in the directions for preparation of sections given in the appendices.

(4) I fear your reviewer will "look in vain" again in the second edition of the book for "the methylene-blue method of Ehrlich for showing nerve endings"; for I shall not forsake the principle I have clearly laid down, that it is useless and inadvisable to preach to students what it is impossible, or at least improbable, that they can practise. The work has no ambition to be an up-to-date histologist's *vade-mecum*.

(5) To say that I state that the process of staining with silver nitrate solution "requires from a few hours to a day or two" is to give an entirely false impression. It is distinctly stated that the tissue requires to be subjected to the reagent for from ten to twenty minutes, and then exposed to daylight "for a few hours to a day or two"—a totally different thing. This is quite sufficient, I think, to demonstrate the unfairness of this part of the review.

(6) The statement in the concluding paragraph that the book is "acknowledgedly compiled from other sources" is absolutely untrue. The usual acknowledgment of indebtedness to current literature is made, and the immediate source is given of some of the formulæ; the latter, however, being as much public property as the dates in English history.

(7) Your reviewer is inconsistent in saying at one time that the drawings are "sadly lacking in accuracy," and at another that "they will rejoice the heart of the average student, who will find them just like his specimens." To say that a student would rejoice over a "gaudy" coloured, uninstructive drawing, lacking in accuracy, and having only a superficial resemblance to his specimen, is not only insulting to his intelligence, but is childish in the extreme.

In conclusion: your reviewer charges the book with inaccuracy in the drawings, and also in the text. I take this to mean that both the text and the drawings, as a whole, are inaccurate, because he does not qualify his hostility by one good word from beginning to end. I deny that he can substantiate his charge. I challenge him to do so as publicly as he has made it.

I am glad to say that your review in its unfavourableness stands alone. The rest of the press, both lay and scientific, has spoken well of the work, and I am sure the editor of NATURE will not be under the impression that that valuable paper is the only one enjoying the services of experts for scientific reviews.

ARTHUR CLARKSON.

Marischal College, Aberdeen, June 29.

IN reply to the above, I beg to assure Dr. Clarkson that the bias of which he complains is solely the result of a critical examination of his book. I have no personal knowledge of him, nor any previous reason for thinking ill of him. I will take his paragraphs in succession:—

(1) Comparison with Klein and Noble Smith's "Atlas of Histology." Dr. Clarkson's temerity in endeavouring to put his book on a par with this classical work, which teems with original observations, and the illustrations to which are drawn with the most minute attention to detail, will raise a smile on the lips of every histologist. He is particularly unfortunate in calling attention to his illustrations of the eye and cochlea, which are vastly inferior to those in the "Atlas," although in the sixteen years since that work was published there has been an enormous advance in our knowledge of the structure of these parts, and notably of the retina. I fail to find a sign of this advance either in the text or illustrations.

(2), (3), (4) That the book is intended for the "ordinary student" (I presume that by ordinary student "medical student" is intended), and does not, therefore, require (to use the author's own language) to be "up to date." Dr. Clarkson seems to be under the impression that there is a special kind of scientific knowledge desirable for medical students, and that it is therefore unfair to have judged his book by a rigid scientific standard. I, on the other hand, hold that a book which is sent to a scientific journal for review must be judged on its scientific merits, and must stand or fall upon these. And if I find two of the most valuable modern methods of investigating the structure of the nervous system omitted, and venture to point out their omission, Dr. Clarkson does not, in my judgment, improve his position by the statement that he has purposely committed this blunder, and that it is his intention to perpetuate it.

There may be a "careful description of the process of staining in bulk," but I have failed to find it. There is no mention of Heidenhain's method, which is largely used in all laboratories.

(5) Dr. Clarkson convicts himself, in having misapprehended my criticism. It is precisely the statement that after silver nitrate a tissue "requires from a few hours to a day or two" exposure in water to daylight that I animadverted upon. Every histologist knows, or should know, the detrimental effect of prolonged exposure to light of such preparations.

(6) It is a sufficient answer to this to give Dr. Clarkson's own words. He says in the preface: "The author would acknowledge his indebtedness generally to the current standard works on the subject; and especially to Prof. Stirling's 'Outlines of Histology' for many of the formulæ of reagents." To this I would, however, add that many points besides the formulæ of reagents have a singular resemblance to corresponding points in Stirling, to say nothing of the other "current standard works" to which no name is appended; and, on the other hand, if there is anything original either in the way of descriptions or methods, I at least have been unable to find it.

(7) I have not made merely a general and unsupported accusation of inaccuracy, but I have given specific instances, which might easily be multiplied were it worth the space they would occupy. Since Dr. Clarkson has in his letter made no attempt to explain these, I take it that he admits their justice, and his public challenge becomes a vain piece of bombast.

Finally, I would add that the fact that the rest of the press has spoken favourably of Dr. Clarkson's work is simply an indication that notices of such books are far too frequently drawn up in a careless and perfunctory manner. The injurious effect which such promiscuous eulogy may have upon an author is only too evident from the tone of Dr. Clarkson's letter.

THE REVIEWER.

A Phenomenal Rainbow.

A VERY beautiful rainbow was observed here on the evening of May 26 last, just before sunset. A light easterly air prevailed at the time; but the thin bank of stratus cloud upon which the bow was projected had drifted slowly across from the south-west, and now hung in the eastern sky. The sun was quite low at the time, and during the last two or three minutes before setting was shining through a thin layer of stratus which lay just above the horizon; but there was no apparent diminution in the startling vividness of colour exhibited in the arch. This extraordinary brightness, however, was not the only noticeable feature; immediately below the great arch, and contiguous to it and to each other, were four narrow arches, in which the vivid colours were repeated; these did not reach the horizon, but faded when about three parts of the way down. There was also, some distance above the main arch, a secondary bow, with the four narrow arches appearing again; but here, instead of being below, they were directly above the arch, and, of course, not so bright as the primary set. The whole appearance was curiously like some of the solar phenomena observed in the Arctic sky, and was so beautiful as to attract the attention of several working bushmen, who are not prone to fall into ecstacies over any natural wonders.

The appearance lasted about five minutes, until the sun was below the horizon; a light shower fell at the time. For some days previously the weather had been thundery and unsettled, with variable winds.

H. STUART DOVE.

Table Cape, Tasmania, June 1.

Fire-fly Light.

IN reply to Prof. S. P. Thompson (p. 126), the insect called in German *Johanniskäfer* or *Johanniswürmchen* is certainly the *Lampyris noctiluca* (glow-worm), of which only the female, which has no wings, is luminous.

But Prof. Muraoka, in *Wiedemann's Annalen*, describes, as *Johanniskäfer*, a Japanese insect which undoubtedly is not the *Lampyris noctiluca*, but a luminous flying insect, very abundant at the end of June. Therefore it would be a *Luciola*, but a little larger than our famous *Luciola italica*, which appears very numerously in all Italy at the end of June.

Gemminger and Harold mention in Japan two *Luciolæ*: *Luciola japanica*, Linn., and *Luciola chinensis*, Thunb., but no kind of *Lampyris*.

CARLO DEL LUNGO.

R. Liceo Galileo, Florence, Italy, July 11.

THE EVOLUTION OF STELLAR SYSTEMS.[1]

ABOUT a century ago Laplace presented to the world an hypothesis concerning the mechanics of the heavens, basing it on sound dynamical principles, and working it out with that genius which he alone at that time could bring to bear. This hypothesis, grand and general as it was and still is, has made his name familiar to every student of astronomy of to-day; and the equipment of a modern observatory enables us to observe more minutely the stellar systems (which he could not see, but only imagine), and wonder at his far-reaching mind in expounding such a simple scheme of evolution for them. Modern investigations have necessitated, however, a modification of Laplace's original hypothesis. In his time the view was held that figures of equilibrium of rotating bodies were necessarily surfaces of revolution about the axes of rotation, but thanks to the mathematical researches of Jacobi, Darwin, Poincaré, &c., this is found now not to be universally true. To-day, for instance, if we consider the revolution of two separate fluid masses so close to one another that they are caused to coalesce and form a rigid system, through tidal distortions, then the form of the resulting mass will be dumb-bell shaped, approximating to Poincaré's apioid. It is regarding the mutual reaction of two such bodies as these that the author of the volume under consideration has recently made mathematical investigations, and he has not limited himself to the purely mathematical side of the problem, but has extended the view to the stars in space, which according to the ideas now held are not solid bodies, but masses of matter in which tidal action can have full play. It seems exceedingly probable, he says, "that the great eccentricities now observed among double-stars have arisen from the action of tidal friction during immense ages: that the elongation of the real orbits, so unmistakably indicated by the apparent ellipses described by the stars, is the visible trace of a physical cause which has been working for millions of years. It appears that the orbits were originally nearly circular, and that under the working of the tides in the bodies of the stars they have been gradually expanded and rendered more and more eccentric."

Dr. See, in the first of the three chapters which composes this volume of more than 250 pages, gives a short historical sketch of double-star astronomy from the time (1779) of Sir William Herschel down to that of Mr. Burnham. The next three sections are devoted to the solution of several problems referring to Laplace's demonstration of the law of attraction in the planetary systems, investigation of the law of attraction in the stellar systems and the analytical solution of Bertrand's problem based on that developed by Darboux, together with the solution given by Halphen. The three following sections treat of problems which Dr. See has previously published in the *Astronomischen Nachrichten*. In the first of these he develops the theory by which, by a simple spectroscopic observation, the absolute dimensions, parallaxes, and masses of stellar systems may be immediately ascertained assuming the orbits are known from micrometrical measurement. In a later chapter he points out how this method may be applied to the best-known doubles. Those most suitably situated for such measurements of relative motion are: η Cassiopeæ, α Canis Majoris, 9 Argûs, ξ Boötis, γ Coronæ Borealis, Σ 2173, 70 Ophiuchi, β Delphini, and α Centauri. The second section gives us a means of rigorously testing the law of gravitation by comparing the observed motion in the line of sight of a companion with the theoretical value.

Sections 8–12 are devoted to a survey of the chief methods of determining the orbits of binary stars. Among these attention may be drawn to a very simple graphical process of finding the apparent orbit from the given elements. Dr. See also properly brings to the fore that admirable graphical method of solving Kepler's equation which was originally invented by J. J. Waterson, and subsequently rediscovered by Dubois. This method, which Klinkerfues describes in his treatise on theoretical astronomy, and which is used by many continental astronomers, is suited to ellipses of all eccentricities, and can be applied, by the addition of a simply determined correction, to the orbits of comets and planets, giving all the accuracy required.

As regards chapter ii. much could be written, since this part of the volume extends over 178 pages out of the 258, and is of great importance. The author has brought together the detailed researches on the motions of the forty stars whose orbits can be best determined at this epoch. For the completion of this work Dr. See has been able to obtain measurements by double-star observers which have not been previously published, and by this means he has carefully determined independently the orbits of these forty doubles, a piece of work which must have involved an immense amount of labour. In the case of each binary are given the observed measures up to date, the previously determined elements and his own elements, and a comparison of the observed with the computed places. There further follow an ephemeris up to the year 1900, and sometimes up to a later epoch, general remarks on the binary in question, and in each case a plate showing the apparent orbit and the positions of the observed companion.

As an illustration of one of the orbits, we may mention that of 70 Ophiuchi, as this is of special interest since the motion of the comparison indicates that a third body is probably in question. Several investigators have worked out the orbit of this double, but there seems always to have been a certain amount of dissatisfaction about the resulting ellipse. The figure shows very clearly the wavy line of motion of the observed with the computed position. Prof. Schur, who made a most rigorous investigation of this binary in 1868 and 1893, discussing 400 observations in the latter year, inspired the belief that at length a definite orbit was obtained, but subsequent comparison of the observed with the computed positions indicated that there must probably be an unseen body disturbing the elliptic motion. Prof. Burnham, who has specially searched for this third perturbatory body, has as yet failed to see it, although he has used the 36-inch Lick refractor in the attempt.

Coming now to the third and last chapter, Dr. See sums up the results of the researches on these forty binaries. A general glance at the table shows that the elements T, a, ☊, i, λ have no relation to physical causes; but, in the case of the eccentricities, "a most remarkable law" is established, which is "of fundamental importance in our theory of the origin and development of the stellar systems, and is besides of practical value to working astronomers." Perhaps the following table will best show the number of orbits corresponding to different eccentricities:—

[1] "Researches on the Evolution of the Stellar Systems. Vol. i. On the Universality of the Law of Gravitation and on the Orbits and General Characteristics of Binary Stars." By T. J. J. See, A.M., Ph.D. (Lynn, Mass, U.S.A.: The Nichols Press, 1896.)

Eccentricities between	No. of orbits.
0·0 and 0·1	0
0·1 ,, 0·2	2
0·2 ,, 0·3	4
0·3 ,, 0·4	8
0·4 ,, 0·5	9
0·5 ,, 0·6	9
0·6 ,, 0·7	2
0·7 ,, 0·8	4
0·8 ,, 0·9	2
0·9 ,, 1·0	0

Mean average value of the eccentricity of the forty binaries, 0·482.

The author thus points out that binaries are distinguished from the planets and satellites in two very distinct respects, namely:

(1) The orbits are highly eccentric.

(2) The stars of a system are comparable, and frequently almost equal in mass.

Dr. See gives a series of illustrations of the orbits arranged in the order of their eccentricity, and remarks that while these are more eccentric than those of the planets and satellites, they are much less eccentric than those of the long-period comets.

The reason why these orbits came to be so eccentric the author evidently leaves to a second volume, as he says that hereafter we shall see that the orbits were originally circular.

In Dr. See's concluding remarks, he points out that these double systems stand in direct contrast to the planetary systems, in which the masses of the components are not in the proportion of two to one, or equal, but where the central body has 746 times as much mass as all of the planets combined.

It is true that investigators, as Dr. See remarks, have always approached the problems of cosmogony from the point of view of our solar system, and have not given sufficient attention to systems of the double or triple star type. This is probably owing to the fact that double star astronomy is practically very modern, and that those investigators were not aware that the telescope would reveal such innumerable systems of double and triple stars as we now know to exist in the heavens. It is further natural that we should consider our system in the first instance a common type of the celestial ones, until it is proved on the contrary to be otherwise. Indeed, such a system as ours need not be in any case an exceptional one in space; looking at a similar one in the heavens, we should most probably only be able to see the central body the sun, in consequence of the smallness of the components (the planets) revolving round it.

It seems likely that such a system would be more easily observed when in the nebulous stage, as, for instance, in those spiral nebulæ which have central nuclei very large compared with the smaller condensations scattered along the outliers.

In conclusion, we may say that we have nothing but praise for this book. By its publication double-star astronomy is greatly enriched, and every double-star observer and computer will find it a valuable addition to his library.

Not only will the exposition of the modern methods of computation of such systems add greatly to its usefulness, but a mine of valuable information regarding the previous researches on the best-known members of double-star systems is brought together in one volume.

WILLIAM J. S. LOCKYER.

THIERRY WILLIAM PREYER.

TO our readers the announcement of the death of this distinguished physiologist will come with surprise. To those who knew Preyer it might have seemed as if he, with that appearance of overflowing vigour, might have looked forward to a long lease of life. It was otherwise, for Preyer died at the comparatively early age of fifty-six of Bright's disease.

Preyer was born in Manchester in 1841, and, after studying in London, he, like most German students, attended several universities, including Bonn, Berlin, Vienna, Heidelberg, and Paris. In 1862 he took the degree of Doctor of Philosophy and that of Doctor of Medicine in Bonn in 1865. In Bonn he was brought under the influence of Max Schultze; in Berlin Helmholtz, Du Bois, and Virchow inspired him with a desire to become a physiologist, while later he worked under Bernard in Paris.

He commenced his independent scientific career as a "privat docent" in Bonn in 1865, and shortly afterwards, in 1869, he was appointed Professor of Physiology in Jena, where his best work was done.

His energy was unbounded, his enthusiasm unquenchable, and so he set to work and had erected the well-known physiological institution in Jena, where he remained until a few years ago, when he resigned his chair, and went to Berlin, where he remained some time, and then retired to live in Wiesbaden.

Preyer's name will always remain associated with his work on hæmoglobin, a work inspired partly by the researches of the Berlin School. The many-sided view of his genius found its expression in the very diverse subjects in which he worked and wrote.

His well-known work "Die Seele des Kindes" (1882) was a study of the mental development of his own child; it amplified and extended the less extensive observations of Darwin.

In the 'seventies his researches were chiefly acoustical, and to-day there exists in the Jena Institute an extraordinary collection of acoustical apparatus which he used for his researches.

About the same time (1877) he published his researches on the cause of sleep.

His "myophysical law" was not so well received by physiologists. Many of his papers and those of his pupils are published in his "Sammlung Physiologischer Abhandlungen" (1876-80), in which will be found his most interesting observations on hypnotism and an allied subject which he called "Kataplexie." Whatever may be thought of his theory, his observations stand, and only this year Verworn, of Jena, has again taken up the subject, and published some most interesting results of "Kataplexie" in serpents. Perhaps Preyer's attention was directed to hypnotism by the works of Braid, of Manchester, which he translated.

As showing the peculiar character of Preyer, and illustrating his never-ceasing quest after something new, we have his physiology of the embryo, which has been translated into French.

Preyer had a ready pen, he was a charming and attractive lecturer, and some of his popular discourses have had a wide circulation.

One of the most pleasantly written of his works is his "Elements of General Physiology," in which he gives a rapid, bold, and characteristic sketch of the development of this subject. This work was also translated into French.

Preyer was the very personification of buoyancy and good humour, and he had an open, frank expression which won for him friends on every hand. He visited England frequently, and those who heard him discourse at the Edinburgh meeting of the British Association are not likely to forget the intense impression he made on his audience, not only by the extraordinary array of facts with which he dealt, but also by the ease and fluency with which he spoke English. Preyer had many of the gifts of an orator, and when his perfervid temperament was roused he carried his audience with him and brought conviction to their minds by the very ardour and force of discourse.

NOTES.

PROF. SCHÄFER asks us to state that members of the British Association who have arranged to go to Toronto must take this year's membership ticket with them in order to secure the railway privileges available.

GRANTS amounting to ninety-five thousand marks (4750*l.*) were awarded for scientific purposes at the last meeting of the Berlin Academy of Sciences. Among these awards were the following:—2000 marks to Prof. Engler, Berlin, for the publication of monographs on African plants; 900 marks to Dr. G. Lindau, for his studies of lichens; 1500 marks to Prof. Frech, for his geological investigations; 850 marks to Prof. Hürthle, for his studies of muscle; 800 marks to Prof. R. Bonnet, for investigations of blood-vessels; 2000 marks to Dr. Lühe, for investigations of the fauna of salt lakes in French North Africa; 300 marks to Dr. G. Brandes, for the study of parasitic Nemertines in Messina; 500 marks to Dr. R. Hesse, for the investigation of eyes of lower marine animals, especially molluscs, at the Naples Zoological Station; 1500 marks to Prof. E. Cohen, for his researches on meteorites; 1500 marks to Dr. Ludwig Wulff, to continue his investigations on artificial crystals; 35,000 marks to Prof. F. E. Schulze, in support of the publication of "Das Tierreich," by the German Zoological Society.

UPON the outer wall of the Pasteur laboratory at the École normale, Paris, a bronze medallion, reproducing with great truth the features of the great investigator, has just been placed. The medallion is the work of M. A. Patey, and it surmounts a slab of black marble bearing in letters of gold the following inscription:—

Ici fut le laboratoire de Pasteur.
1857.—Fermentations.
1860.—Générations spontanées.
1865.—Maladies des vins et des bières.
1868.—Maladies des vers à soie.
1881.—Virus et vaccins.
1885.—Prophylaxie de la rage.

This memorial was voted by the Municipal Council of Paris in December 1894 to commemorate the work done by Pasteur in the laboratory in the rue d'Ulm, now occupied by the École normale.

AN important change in the administration of the U.S. National Museum is announced in *Science*. Three sections have been organised—a section of anthropology, a section of biology and a section of geology, each having a head curator with an annual salary of 3500 dollars. Dr. W. H. Holmes has been appointed head curator of anthropology; Dr. Frederick W. True, head curator of biology; and Dr. George P. Merrill, head curator of geology. Dr. True and Dr. Merrill are already connected with the Museum, and it is expected that Dr. True will continue to act as the executive curator. Dr. Holmes, who leaves the Field Columbian Museum, Chicago, to accept this position, was formerly connected with the U.S. Geological Survey and the Bureau of Ethnology.

DR. ALFRED M. MAYER, professor of physics at the Stevens Institute of Technology since the foundation of that institute, died on July 13, aged sixty-one years. He was a Member of the National Academy of Sciences, and one of the original Fellows of the American Association for the Advancement of Science.

THE statue of Darwin that has been erected by the Shropshire Horticultural Society at the entrance to the Public Library and Museum, the former school buildings, of Shrewsbury, will, says *Natural Science*, be unveiled by Lord Kenyon, President of the Society, on August 10. The statue, which is of bronze on a granite pedestal, is the work of Mr. Horace Montford, of Shrewsbury, and is not wholly unlike the fine statue in the Natural History Museum, South Kensington.

THE Council of the British Institute of Preventive Medicine have appointed Dr. Allan Macfadyen Director of the Institute.

THE British Medical Association has awarded the Stewart Prize of 50*l.* to Dr. G. Sims Woodhead, and the Middlemore Prize of 50*l.* to Dr. Alexander Hill. Sir Walter Foster and Mr. C. G. Wheelhouse have been awarded the gold medals for distinguished merit.

CARBIDE of calcium not exceedingly 5 lbs. in quantity, when stored in separate, substantial, hermetically-closed metal vessels, containing not more than 1 lb. each, may now be kept without a licence, the Secretary of State having been advised that such small quantities might be safely exempted from the operation of the Order of Council of February 26, in which certain parts of the Petroleum Acts were applied to the substance.

THE preliminary programme of the sixteenth congress of the Sanitary Institute, to be held in Leeds, from September 14 to 18, has now been issued. The president of the congress is Dr. Robert Farquharson, M.P. The congress will include three general addresses and lectures. The sections will meet for two days each, and deal with (1) sanitary science and preventive medicine, presided over by Mr. T. Pridgin Teale, F.R.S.; (2) engineering and architecture, presided over by Mr. Lewis Angell; (3) chemistry, meteorology, and geology, presided over by Mr. William Whitaker, F.R.S. There will be six special conferences, the subjects and presidents of which will be "River Pollution," Major Lamorock Flower; "Municipal Representatives," Councillor B. Wormsley; "Medical Officers of Health," Dr. Edward Seaton; "Municipal and County Engineers," Mr. Thomas Hewson; "Sanitary Inspectors," Mr. Peter Fyfe; "Domestic Hygiene." In connection with the congress a health exhibition of apparatus and appliances relating to health and domestic use will be held. Excursions to places of interest in connection with sanitation will be arranged for those attending the congress. It appears from the programme that over three hundred authorities, including several County Councils, have already appointed delegates to the congress, and, as there are also over two thousand members and associates in the Institute, there will probably be a large attendance in addition to the local members of the congress.

AT a very numerously attended meeting of the Essex Field Club, held at Easton Lodge, near Dunmow, by the invitation of the Earl and Countess of Warwick, on Wednesday, July 21, a discussion was held for the consideration of practical methods for the protection of our native fauna and flora from the destruction and actual extermination which now threaten many interesting species. Mr. C. G. Barrett (hon. secretary to the Committee of the Entomological Society for the Protection of Insects in danger of extermination) opened the subject by a short address on "Insect protection: its necessity, means, and objects." Mr. J. E. Harting spoke with respect to birds and mammals; Prof. Boulger referred to the wholesale collecting which was exterminating many rare plants; and Prof. Meldola urged that children should be taught to respect the sacredness of life. The President, Mr. David Howard, strongly supported the pleas of the speakers, and Mr. W. Cole hinted at the injury that might be caused by legislative interference with the balance of nature. Eventually the following resolution of Prof. Boulger's was adopted unanimously, and the Club resolved to assist the scheme of the Entomological Society in every possible way: "That in view of the danger of extermination threatening many beautiful, rare and interesting plants, all lovers of nature should do their best to avoid this danger (*a*) by abstaining from wholesale collecting, collecting for merely individual private

collections, needless rooting-up of specimens, attempting to cultivate wild specimens of refractory species, and purchasing such wild specimens from itinerant or other dealers; (*b*) by endeavouring to persuade others, especially school children, cottage gardeners, and dwellers in large towns, to a similar abstention." It is to be hoped that other local natural history societies will follow the example of the Essex Field Club, and bring this pressing matter prominently before their members.

THE first section of an interesting Russian expedition which was at work this spring, in Bukhara, under Colonel Kuznetsoff, has just returned to Tashkend. Although the Khanate of Bukhara is open to Europeans, and the Russian Turkestan Railway crosses it, the Khanate remains one of the least-known parts of Central Asia as regards its population and economical conditions. The new expedition had precisely these studies in view. It has visited the chief towns of Bukhara, as also the desert portion of the banks of the Amu for 190 miles, between Pata-ghissar and a lonely village Sarai, and has explored the region of Sarygor. It returns with valuable materials, and with a great number of photographs.

A SCIENTIFIC expedition was sent to Central Borneo, in 1893, by the Dutch Society for the advancement of natural history exploration in the Dutch colonies. Prof. Molengraaff went out as geologist, Dr. Hallier as botanist, and Dr. J. Büttikofer as zoologist, while Dr. Nieuwenhuis undertook the study of the anthropology and ethnography of the natives. A concise description of the field of exploration and a general statement of the zoological results is contributed to *Notes from the Leyden Museum* (vol. xix., published July 15) by Dr. J. Büttikofer. In the same publication, Dr. F. A. Jentink describes the mammals collected during the expedition.

THE most important matters which the Trustees of the South African Museum refer to in their report for the year 1896 are the reorganisation of the staff, and the completion of the new buildings recently described in NATURE (p. 31). The scientific staff of the Museum now stands as follows:—Mr. W. L. Sclater, Director and Keeper of the Department of Vertebrates; Mr. L. Peringuey, Assistant-Director and Keeper of the Department of Insects; Dr. W. F. Purcell, Assistant and Keeper of the Department of Land Invertebrates; Dr. G. S. Corstorphine, Keeper of the Department of Geology and Mineralogy; Dr. J. D. F. Gilchrist, Honorary Keeper of the Department of Marine Invertebrates. The total number of specimens added to the collections during the year was 8009, of which 900 species were new to the Museum. Evidence of increasing interest in the Museum is shown by the fact that the number of visitors in 1896 was 49,419, this being an increase of nearly eleven thousand upon the number of the previous year, and by far the highest number yet registered. Mr. Peringuey refers to the discovery, by Surgeon-Major Bruce, that the dreaded Tsetse-fly (*Glossina morsitans*) is a larviparous insect, *i.e.* it gives birth to a full-grown larva, which, very shortly after being extruded, pupates, the external skin or puparium hardening and assuming an ovate shape, auriculate at one end. This discovery, so much at variance with what is known of the life-history of kindred dipterous insects, was at first doubted, but Mr. Peringuey says he can authenticate it, for he has bred from puparia, sent to him by Sir Walter Hely-Hutchinson, the Governor of Natal, what is undoubtedly the *Glossina morsitans* of Westwood.

THE vast and sudden changes of wind-velocity occurring in stormy weather, which were revealed by Prof. Langley's observations published in 1893 in his essay on "The Internal Work of the Wind," have been made the subject of a novel investigation at the hands of Dr. Romei Martini. In the *Rendiconti del Reale Istituto Lombardo*, Dr. Martini describes a series of observations on the periodical and other variations in the level of water in wells, and has proved the existence of rapid fluctuations corresponding very closely with the fluctuations of wind-pressure during a storm, of which latter he also gives diagrams closely resembling Langley's. The old and well-known tradition, that a sudden rise or fall of water in wells may be used to predict bad weather, has thus received explanation; but the most remarkable feature is that while small and rapid fluctuations of pressure readily make their influence felt on the instrument for registering the level of the well, large variations in the barometer are much more uncertain in their action.

IN the *Monthly Weather Review*, considerable attention is now being given to kites and their use in exploring the upper air. The number in which the weather of April 1897 is discussed, contains a long monograph by Prof. C. F. Marvin dealing with the theory of the mechanics and stability of kites. In addition, the editor (Prof. Cleveland Abbe) gives some interesting historical facts relating to the early history of kites, and a controversy as to the earliest use of wire for kite-lines shows that experiments with wire were made in 1836 at Philadelphia, and in 1844 by Mr. Joshua Law in England. We also learn that just as the European meteorological bureaus have taken up sounding balloons as a means of exploration at great altitudes, the United States Weather Bureau has prepared kites to cover a great horizontal extent of territory with automatic meteorological instruments. While the European system is designed for special occasional work at 50,000 feet altitude, the American system of kites contemplates regular daily work at 5000 feet. Probably both systems will in time supplement each other.

THE current number of the *Zeitschrift für Hygiene* contains an elaborate memoir by Dr. Max Neisser, of the University of Breslau, on the correct diagnosis of diphtheria bacilli. Amongst the many interesting and important points investigated, considerable attention is directed to the production of acid in culture media by these bacilli. This has long been regarded as a characteristic feature in the growth of diphtheria bacilli; but Dr. Neisser has made a new departure in estimating the amount of acid elaborated, quantitatively. It appears that during the first nine hours no increase was observed, but at the end of the first day a considerable quantity was discovered, and that it materially increased in the course of the second day; after that period, however, no further rise was recorded. So far Dr. Neisser has only met with one variety of bacillus resembling that of diphtheria, which possesses this power of elaborating acids in such quantity. Some very interesting investigations are recorded on the rate of multiplication exhibited by diphtheria bacilli grown in serum, and then plate-cultivated in agar dishes for numerical determinations. The original number inoculated consisted of 1½ million diphtheria bacilli; after six hours this figure was transformed into 60 millions, after nine hours into 500 millions, and after twenty-four hours into 1100 millions. The growth in serum between the sixth and ninth hour after inoculation is, therefore, particularly prolific. In broth the multiplication is much slower, and at the end of twenty-four hours only about 120 millions of diphtheria bacilli were found, which, if contrasted with the 1100 millions recorded at the end of that time in blood-serum cultures, is very striking. Dr. Neisser's laborious investigations should prove of great value to all concerned in the bacterial diagnosis of diphtheria.

IN a recent number of the *Bulletin* of the Geological Society of America, Prof. Tarr describes some of the results of his study of the Greenland glaciers during the summer of 1896. In opposition to the views of other recent observers, he considers there is ample evidence of a former much greater extension of

the ice. He points out that it is not safe to assume that a rugged peak has escaped ice-action, since there is plain evidence that certain peaks have been overwhelmed by the ice without losing their ruggedness. Two incidental discoveries given in this paper deserve special mention. One is the finding of recent marine shells in the boulder-clay of a moraine fifty feet above sea-level, and also in the ice itself of the glacier that had brought them there—a fact of great interest to British glacialists, in view of recent controversies. The second refers to the flora of a nunatak (Mount Schurman), regarded as but recently exposed above the ice: only light-seeded plants are said to have reached it as yet. A thorough study of the flora of nunataks would doubtless be as interesting as that of volcanic islands.

A VALUABLE paper has recently been published by Mr. C. S. Myers, giving "An account of some skulls discovered at Brandon, Suffolk" (*Journ. Anth. Inst.*, xxvi. p. 113). Brandon is the site of the famous flint quarries which are believed to have been worked continuously since the Neolithic period. In the vicinity are two Roman camps, and near by runs the Icknield Way, the great war- and trade-route of the Iceni in pre-Roman times. A few skulls resemble the "Neolithic" or "Long Barrow type." The skulls of brachycephalic series do not belong to the "Round Barrow type," which is quite unrepresented, but are to be allocated to a fairly widely-spread "Romano-British type." Among the elongated skulls Mr. Myers has proved the occurrence of the old "Row-Grave type" of Germany; it is a significant fact that about 372 A.D. the Alemannic Bucinobantes came from Mainz on the right bank of the Rhine, and appear to have settled, within twenty miles of Brandon, at Buckenham in Norfolk. Allied to these skulls is the long, low-crowned "Batavian type," which also occur at Brandon. Only one definitely Saxon skull was noted. The evidence points to the fact that the burial-ground whence these skulls were obtained was that of a people of mixed ethnic character belonging to a time antecedent to the Saxon Invasion; but it is probable that even then Saxon settlers were arriving in small numbers.

THE curious custom of trepanning—that is, of removing small pieces of bone from the living head—is very ancient and widely spread. In his recently-published book, "Prehistoric Problems," Dr. Munro has devoted a chapter to "Prehistoric trepanning and cranial amulets." About the same time, Drs. H. Malbot and R. Verneau published in *l'Anthropologie* (tome vii.) a memoir on the Chaouias and the trepanning of the skull in the Aurès. The Djebel-Aurès, "Mountains of the Cedars," form the south-east border of the Algerian plateau; here and in the neighbouring Djebel-Chechar is the centre of trepanning. The natives are carefully described; they belong to the Berber stem; a portion—perhaps one-eighth—are fair; thus the external, as well as the cranial, characters show them to be a somewhat mixed people. The method of trepanning is very fully described, and a native doctor showed Dr. Malbot a skull with over a dozen circular holes, two slits, and a large irregular orifice, all of which had been pierced when the man was alive! The skull, though taken from a grave, was kept hidden, and it evidently was used as an example by the local doctors. The enthusiastic French doctor says "the Chaouias respect their tombs, and on no pretext will rifle them; the love of science alone can explain this profanation on the part of our trepanner. It is the same sentiment which has led to our possession of the specimen." Dr. Malbot describes how he acquired the specimen which is now in the Museum d'histoire naturelle in Paris. The natives have recourse to trepanning for blows or wounds on the head; it does not matter how long before the blow may have been given, if only a sick person can remember that he has had one. The operation is by no means a severe one, as the people have a most remarkable recuperative constitution. A woman, tired of the conjugal yoke, has been known to call in the services of a trepanner in order to procure a divorce from her husband by producing a piece of her skull, which she affirmed had been broken by his ill-treatment.

THE useful services rendered by ladybirds in ridding fruit trees of insect pests were referred to in an article in NATURE of March 25 (vol. lv. p. 499). Further information upon the subject is given by Mr. C. L. Marlatt in the "Year-Book of the U.S. Department of Agriculture," in an article describing the various methods employed to combat the ravages of injurious insects in California, where the possibility of control of insects by introducing and fostering their natural enemies has been thoroughly tested. The very notable instance of the entire eradication of the white scale insect by the introduction from Australia of its ladybird enemy, *Vedalia cardinalis*, demonstrated the possibilities in this direction in the most striking way. This one experiment saved the State its citrus industry, and gave the greatest confidence in many quarters in this means of controlling insects, as well as incited the later action looking to the introduction of beneficial insects on a much larger scale. It led the State of California, in 1891, to grant 5000 dols. "for the purpose of sending an expert to Australia, New Zealand, and adjacent countries to collect and import into this State parasitic and predaceous insects." Mr. Albert Koebele, who had previously been instrumental in introducing *Vedalia cardinalis*, was selected for the work. His chief object was to obtain predaceous insects which might exterminate the black scale, the red scale, and the San José scale. Mr. Koebele's mission lasted upwards of a year, and during this time he imported into California probably 60,000 specimens, representing very many species, chiefly of ladybirds. Five or six of these species took hold well from the start, and two or three of them are still represented abundantly in the orchards of California, the others having practically disappeared. The important ones remaining include a very efficient predatory enemy of the black scale in the little *Rhizobius ventralis*, and two much smaller species, *R. debilis* and *R. toowoombæ*, which attack the black scale, and also the red scale and San José scale to a less extent. *Rhizobius ventralis* was easily colonised, and during the last three years has been distributed in enormous numbers to different parts of the State, 300,000 or 400,000 having been colonised in Southern California alone. This beetle is by far the most useful of the recent importations, and has already done much good; in several instances it has effected the entire eradication of the black scale in badly infested orchards. The disappearance of the scale may in some cases be due to other natural causes, but there seems to be no doubt that the chief credit belongs to the ladybirds. Once the ladybirds have established themselves in sufficient numbers, it seems best not to spray or fumigate the trees, as these treatments are very prejudical to the multiplication of this beneficial beetle.

ON Monday, August 2 (Bank Holiday), the Yorkshire Naturalists' Union will hold a meeting at Market Weighton, for the investigation of Everingham Park and surrounding woods and the low-lying Carr-land in the district.

WE have to acknowledge the receipt of "*Bulletin* No. 1 of the Free Museum of Science and Art, Department of Archæology and Palæontology, University of Pennsylvania." The object of the bulletin, which will be published four times a year, or as frequently as occasion may require, is the publication of new material acquired by the Museum, with accounts of explorations conducted by the Museum, and original investigations based upon its collections. The present issue contains

articles by Dr. D. E. Brinton, entitled "The Pillars of Ben" and "The So-called 'Bow-Puller,'" besides brief notes on collections and publications.

THE following are among the papers and other publications which have come under our notice during the past few days:—"Life in Sewers," by Mr. H. A. Roechling, in the *Transactions* of the Leicester Literary and Philosophical Society (vol. iv. part iii., 1897). The paper is an instructive account of bacterial life found in the sewage itself and in sewer air, and the diseases produced by it.—A paper on the distribution and migration of Colorado birds, by Mr. W. W. Cooke, is published as *Bulletin* No. 37 of the State Agricultural College, Fort Collins, Colorado. The total number of species and varieties of birds which occur in Colorado is 360, of which 228 are known to breed. This is said to be a larger number of species than has been taken in any State east of the Mississippi, and is only exceeded by Nebraska with nearly four hundred species.—The tidal phenomena of the St. John River, New Brunswick, Canada, at low summer level, are described by Mr. A. Wilmer Duff in the *Bulletin* of the Natural History Society of New Brunswick (No. xv., 1897.) Dr. G. F. Matthew contributes to the same bulletin a long review of the scientific work of Dr. Abraham Gesner, the geologist.—The Pasteur Memorial Lecture delivered by Prof. Percy Frankland before the Chemical Society on March 25, and reported in NATURE at the time (vol. lv. p. 518), is printed in full in the July *Journal* of the Society, with an excellent portrait of Pasteur.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by Mr. W. H. Stather; a Brown Capuchin (*Cebus fatuellus*) from South America, presented by Mr. D. Mackintosh; a Harnessed Antelope (*Tragelaphus scriptus*, ♂) from West Africa, presented by Mr. R. B. Llewelyn, C.M.G.: a Vulpine Squirrel (*Sciurus vulpinus*) from North America, presented by Messrs. A. G. and R. Rawlins; a King Parrot (*Aprosmictus syanopygius*) from Australia, presented by Mrs. R. L. Turner; a Crowned Horned Lizard (*Phrynosoma coronatum*) from California, presented by Mr. C. H. Hastings; a Daudin's Tortoise (*Testudo daudini*) from the Aldabra Islands; a West African Python (*Python sebæ*) from West Africa, deposited; a King Vulture (*Gypagus papa*) from South America; a Bronze-winged Pigeon (*Phaps chalcoptera*) from Australia, purchased; a Peacock Pheasant (*Polyplectron chinquis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW OBSERVATIONS OF VENUS.—During the first three months of the present year, Dr. Eduardo Fontseré, of the Observatory of the Royal Academy of Sciences, Barcelona, made a series of observations of the planet Venus with a refractor of 11 cm. belonging to that observatory. An account of these observations is briefly described in the current number of the *Astronomischen Nachrichten* (No. 3430), and is accompanied by numerous figures illustrating the different surface markings that were recorded. The colour of the planet was noted as being of a yellowish green tinge, the most brilliant regions of the disc being less coloured than the others. The polar regions were not found to resemble those on Mars. Attention was paid especially to the dark and light spots on the disc, which were at times very conspicuous. We cannot here enumerate the various differences of shade observed, but we may mention the most brilliant noticed, namely, that situated near the south pole, and forming the letter X by the crossing of two arcs of circles. Dr. Fontseré classifies the bright regions into two divisions: those which are, to all intents and purposes, permanent, but of a variable nature, increasing and decreasing in relative brightness between certain limits; and those which appear like white trails always inclined towards the equator, but never parallel to it. As in the observations of Trouvelot, large deformations of the terminator were distinctly noticed, but are attributed for the most part to irradiation. The extremities of the horns were also found to be sometimes prolonged into the non-illuminated portion of the disc. The observations during these three months have indicated that, relatively to the sun, Venus has not undergone any rotation except as regards the small libration, which was exactly equal to that which corresponded to the change of geocentric latitude. The above-mentioned observations form a valuable contribution to our present knowledge concerning the telescopic appearance and time of rotation of this planet.

THE YERKES OBSERVATORY.—In the June number of the *Astrophysical Journal*, Prof. Hale brings to a conclusion his series of articles on the Yerkes Observatory and Telescope. The concluding article is elaborately illustrated, showing the telescope and dome in various stages of construction, the frontispiece illustrating the stage reached on May 11 last. We notice that the dedication of the observatory will take place on October 1 next, and it is hoped "that European men of science who propose to attend the Toronto meeting of the British Association in August, may think it desirable to take part in the formal inauguration of the Yerkes Observatory. . . . It is planned to hold a series of informal conferences on astronomical and astrophysical subjects. . . . A cordial invitation is hereby extended to all men of science who may be willing to honour the observatory by their presence on this occasion."

RESOLVING POWER OF SPECTROSCOPES.—In this column, on May 20 (p. 62), we referred briefly to Prof. Wadsworth's investigations on the question of the theoretical resolving power of optical instruments, in which he distinguished between four different cases. In this work he obtained formulæ which gave the three different resolving powers, namely, (1) p (theoretical) for a wide slit and monochromatic radiations; (2) R (limiting) for an infinitely narrow slit, but for lines of finite width $\Delta\lambda$; and (3) P (practical) for a wide slit and non-monochromatic radiations ranging for each line over a small value $\Delta\lambda$. In the current number of the *Astrophysical Journal* (vol. vi. No. 1), he now publishes tables which he has prepared, giving the values of p, R and P for values of r, which gives the value of the theoretical resolution of the instrument for an infinitely narrow slit and infinitely narrow spectral lines. In these tables r ranges from 25,000 to 1,000,000, $\Delta\lambda$ from 0·01 to 1·00 tenth metres, s (linear width of slit) from 0·005 mm. to 0·3 mm, and Ψ (angular magnitude of collimator as viewed from slit) from 1/40 to 1/10. All the values are computed for $\lambda = 5500$ tenth metres, this being the mean wave-length of the brightest part of the visible spectrum. Prof. Wadsworth adds also a complete explanation of the use of these tables, and numerous important remarks.

THE HORIZONTAL GYROSCOPE.—Attempts have several times been made to eliminate the use of the horizon when employing a sextant on board ships, by adopting mechanical or other means of determining the horizontal or vertical. Among these may be mentioned the pendulum in a collimator devised by Colonel Goulier, the mercury siphon of M. Renouf, and other ingenious devices suggested by Lejeune, Cardan, &c. None of these seems, however, to have come into practical use, and the mariner is still using the sextant in its ordinary form. Another rather novel mode of determining the horizontal is described by M. Gaspari in the *Journal de Physique* (vol. vi. p. 229). This idea was proposed by Rear-Admiral Fleuriais, and from all accounts seems to be of practical use. It consists in making a small addition to an ordinary sextant by mounting in front of the telescope and behind the small mirror a horizontal gyroscope which contains on its upper part two small plano-convex lenses, equal in all respects, placed a distance apart equal to their focal length. On the plane faces of these lenses are engraved two lines parallel to the equator of the gyroscope, and this plane contains their optical centres. The gyroscope is given a motion of rotation from 80 to 100 turns a second under some conditions. The horizontal is obtained by observing the position of the *locus* of these lines as the lenses revolve. To describe the method of working, and give an idea of the theory of the instrument, would occupy too much space in this column. We may mention, however, that the instrument has been used both on land and sea, and the officer who made the experiments "est arrivé à etablir que l'appareil est definitivement devenu pràtique." With a telescope magnifiying from 3 to 4 diameters an approximation of 2′ was obtained under ordinary conditions of observation, but generally greater accuracy than this was secured.

SOME PROBLEMS OF ARCTIC GEOLOGY.

I. THE POLAR BASIN.[1]

UNTIL the return of the *Fram* from its epoch-making drift, the belief was almost universal[2] that the Arctic Ocean is a shallow, island-strewn sea; and the evidence for this view was thought to be so conclusive, that theories of Arctic geology might be safely based upon the hypothesis. Facts inconsistent with the theory were not unknown. Scoresby had let out two miles of line west of Spitsbergen, and Parry had sounded with a 500-fathom line at his furthest north, and on neither occasion was the bottom reached; Nordenskjold, in the *Sofia*, had found that the sea at 81° 32′ N. and 17° 30′ E. was 1300 fathoms deep. But this direct evidence did not shake the widespread belief in the general shallowness of the areas where no direct evidence was available. This theory was originally based on the notion that ice cannot be formed on the sea except where it is shallow; and after this view was proved to be mistaken, the old conclusion was maintained by various authorities from many different considerations. Thus Petermann, the great German Arctic geographer, deduced the extension of Greenland across the Pole to Wrangel Land near Behring Straits, from the distribution of drift-wood. It is well known that the Siberian rivers carry down vast quantities of tree-trunks, which float across the Arctic Ocean, and are cast upon its shores. But there is very little of this drift-wood in the Robeson Channel, and at the northern end of Smith's Sound. Petermann, therefore, concluded that there can be no direct sea communication between that strait and the coast of Northern Asia. While Petermann inferred the existence of a land connection between Greenland and the Asiatic islands from the discontinuity of the sea, Sir Allen Young, even as late as 1893, held that there is direct evidence of its actual existence; for the Governor of Upernivik, the most northern Danish settlement in Greenland, received from a native hunter a reindeer skin which had been branded with one of the marks used in Siberia; hence Young argued that this reindeer must have walked across from Siberia, which it could only have done along a line of continuous land, or, at least, a chain of islands. The existence of land to the north of Greenland was also maintained by Captain Tyson, the chronicler of the Hall Expedition, owing to the very moderate current that flows southward down Robeson Channel, which, it was said, could only be explained by the assumption that a northern archipelago acted as a weir. Again, Admiral Sherard Osborn contended that the sea to the north of the Parry Islands is a land-locked basin, as its characteristic icebergs never pass out through either Smith Sound or along the eastern coast of Greenland; and the occurrence of land to the north of Spitsbergen was asserted, as flocks of birds fly northward as if on their way to a safer breeding-place.

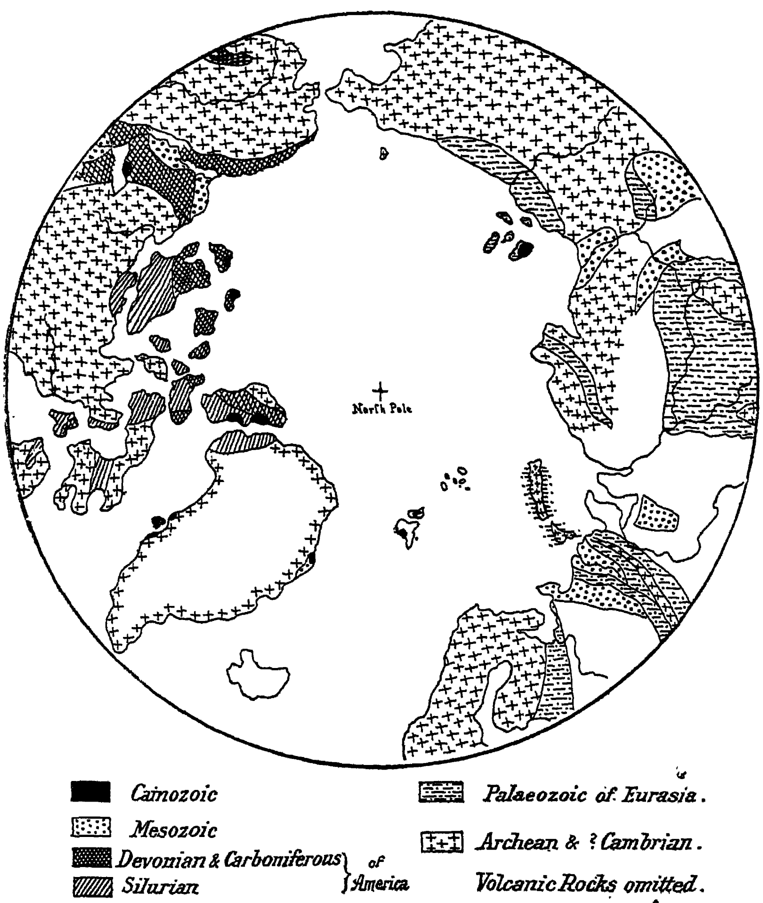

FIG. 1.—Geological Sketch Map of Polar Regions.

How firmly ingrained this view of the shallowness of the Arctic Ocean had grown, cannot perhaps be more strikingly illustrated than by the fact that the *Fram* was only supplied with apparatus for sounding in comparatively slight depths. Accordingly, geologists and biologists were permitted to introduce great changes in the size and position of the Arctic Ocean without any objections being raised. Thus Sir J. D. Hooker was allowed to call up great land areas from the Arctic deeps, to account for the apparent eccentricities of plant distribution. When Sir Chas. Lyell explained the vicissitudes of Arctic climates by a different arrangement of land and water in the North Polar regions, no *à priori* protests were made. But the sounding-line of the *Fram* has changed all that, for it has introduced into Arctic geology the theory of the permanence of oceanic basins. If that theory be true, then throughout the æons of geological time a large part of the Polar area has been occupied by a vast, deep reservoir of water. In that case many of the problems of British geology require solutions, different from those which have hitherto been deemed satisfactory.

The question whether the Polar Basin has been permanent, and, if not, at what age it has been formed, is the problem of greatest geological importance raised by the voyage of the *Fram*.

In the case of the other oceans, biological evidence is fortunately available. Thus a map of the world marked off into botanical regions, shows that in the tropics and the southern hemisphere the ocean basins separate distinct floras. Thus South America, Africa, and Australia now belong to different botanical regions, so that these three continents must have been separated from one another for a very long period. But palæo-botanical evidence shows that in Triassic times they were inhabited by the same flora; and therefore, during or immediately preceding that period, they were not so completely separated by ocean barriers as they are to-day. But in the case of the Arctic Ocean we get no such assistance from biological evidence, for one flora and one fauna extend uninterruptedly through all the Arctic lands. This uniformity may have resulted from the original development of this flora and fauna in some land around the Pole, whence they spread radially into Europe, Asia and America. But, on the other hand, it may have resulted from an east or west diffusion along the circum-arctic belt of land. That this land has not always been arranged as it is at present, is rendered almost certain by the minor differences that occur in the floras of different parts of the Arctic zone. For example, the line of separation between the American and European subdivisions of the Boreal botanical realm does not run between Greenland and Iceland, but between Greenland and the rest of the American archipelago. In fact, according to Hooker and

[1] As limits of space prevented the insertion of adequate references to authorities, it has been thought advisable to omit them altogether.

[2] The principal opponent of this view was Dr. J. Murray.

Nathorst, Greenland botanically belongs to Europe, and not to America. Though this throws doubt on the permanence of the separation of Greenland and North-west Europe, it does not prove any change in the Arctic Ocean inconsistent with the theory of the permanence of ocean basins. As we, therefore, cannot prove that the resemblances between the inhabitants of the Arctic lands on opposite meridians have been established by migration across the Arctic Ocean, instead of around it, we cannot hope for much help from biological evidence in determining the age of the Arctic Basin.

We are therefore compelled to rely on the facts of the stratigraphical geology of the Arctic regions, of which a short outline is accordingly advisable. This is illustrated by the accompanying sketch map (Fig. 1). The rocks of the Arctic regions belong to the following systems: the Archean, Cambrian, Silurian, Devonian, Carboniferous, Triassic, Jurassic, Cretaceous, Lower or Middle Tertiary, and Pleistocene.

The largest part of the Arctic land is occupied by rocks belonging to the Archean system. They form the whole foundation of Greenland, and occur in Baffin's Land, Labrador and the eastern part of British North America; westward they plunge below the Devonian and Cretaceous rocks of the Mackenzie River Basin, and reappear in the Yukon River and in Alaska. They occupy an enormous extent of Siberia, reappearing at intervals beneath Palæozoic rocks and Pleistocene tundras: they form the backbone of the Ural mountains, and of their northern continuation the islands of Nova Zemlya; west of the White Sea they cover nearly the whole of Finland, the Kola Peninsula, and Scandinavia, and a ridge of them extends up Western Spitsbergen, and forms most of North-East Land and its off-lying islands.

The age of the next series is somewhat uncertain. Its members overlie the Archean rocks unconformably, while they are always earlier than any fossiliferous beds with which they may be associated. The series consists of red sandstones and coarse conglomerates, with quartzites and dolomites. The rocks are regularly bedded, and are often horizontal; but they may be violently contorted and roughly cleaved. This series does not form huge continental blocks like the Archean, but occurs as a belt which may at one time have been continuous around the Arctic Ocean. Representatives now occur in northern Norway and Spitsbergen; in eastern, western and southern Greenland, in Labrador, the basin of the Coppermine River, and at one or two places on the Siberian coast. Fossil remains occur occasionally, but none have yet been described which settle the age of the series. But from stratigraphical considerations this series is probably of Lower Cambrian, or possibly Torridonian age.

In the next system representative fossils are abundant, and they show us that in Silurian times a large part of the Arctic area was covered by a sea, whose waters were warmer than those of the present Arctic Ocean. The Silurian rocks occur in belts. One belt runs down Smith's Sound, and then, bending westward, crosses the islands of North Devon, North Somerset, and Victoria Land. So that the Silurian Sea apparently covered most of the American Archipelago, and extended up two gulfs, of which one ran across Baffin's Land, and another up Hudson's Bay. But most of Arctic North America was then above the sea. The shore line of the Silurian Arctic Ocean skirted the American coast as far west as Cape Parry; thence it swept northward, and it is not until we reach the Indigirka River and the new Siberian Islands that we again find exposures of Silurian rocks. In the basins of the Indigirka, Lena, and Yenesei the Silurian limestones occupy a wide extent of country; but approaching Europe the land again extended northward, and it is even possible that there was no direct communication between the Silurian Arctic Ocean and the seas that then covered parts of England and occupied the basin of the Baltic. If any connection existed, it probably occurred as a strait from the Gulf of Finland to the White Sea.

In the succeeding Devonian period the Arctic Sea was larger: one arm of it ran up the basin of the Mackenzie River, and covered a wide tract in British North America. In North-eastern Europe a similar inroad of the sea had occurred; for marine Devonian deposits are known from Nova Zemlya and the flanks of the Ural Mountains, and they cover a large part of the district of Timan and the Petchora Basin.

The accompanying sketch map (Fig. 2) illustrates the probable limits of the Arctic Sea in the Silurian period, and the extent of its transgression in the Devonian.

In addition to the marine Devonian deposits, others are known which were probably formed on land or in inland seas; but more satisfactory evidence of land conditions occurs in the Carboniferous period, when the extent of the land was probably much greater. In Arctic America the sea had withdrawn to the north, and only covered the north-western part of the American Archipelago, the central belt of Grinnell Land, and part of Southern Alaska. All Europe north of the sixtieth parallel was a land area, except for a gulf in the Timan region of North-eastern Russia: Nova Zemlya was then an island chain, while most of Spitzbergen was submerged. But the advance of the sea in this area was more than counterbalanced by its recession from Eastern Siberia.

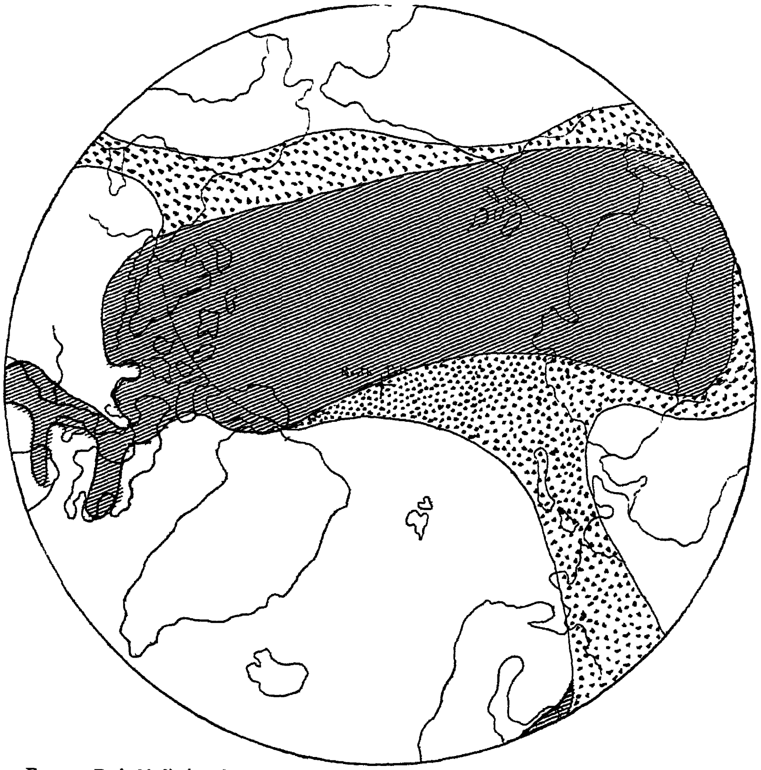

FIG. 2.—Probable limits of the Arctic Ocean in the Silurian (lined area) and of its transgression in the Devonian (dotted area).

The Triassic Arctic Ocean was probably smaller than that of the Carboniferous period. The retreat of the sea from the American Archipelago, which had been gradually taking place throughout Palæozoic times, was now complete, but marine Triassic rocks in Arctic America are known from Alaska. In the Old World the best-known Triassic deposits are the barren red sandstones of various parts of north-western Europe; but a sea, inhabited by a very rich and interesting fauna, then occupied the Mediterranean area, covered most of Switzerland, and stretched eastward across the Balkan Peninsula into Russia, and possibly into India. At the same time a great Triassic sea lay to the north of Europe and Asia; it covered Spitsbergen and, probably, also Franz Josef Land, and skirting the Eurasian coast-

line as far as the Lena, then spread southward into the Amur Valley; it thus reached the sea of Okhotsh, whence one coast ran southward across Japan, and the other eastward to Alaska. From many Arctic localities these Triassic rocks are rich in fossils; but the fauna of the Triassic Arctic Ocean is so different from that of the contemporary Mediterranean Sea, that it is doubtful whether there was any direct connection between them.

After the close of the Trias there is a considerable gap in the annals of the Arctic Ocean. When the record is resumed in the middle and upper parts of the Jurassic period, we find that the sea has either again grown very considerably, or has materially shifted its position. Thus the sea, instead of ending near Spitsbergen, has encroached to Greenland on the west, and extended southward to the Lofoten Islands, to southern Sweden and to England, France and Germany; and further east a series of gulfs ran southward up the valleys of the Petchora, Obi, Yenesei, and the Lena. The Jurassic Arctic Ocean, therefore, appears to have been connected with whatever sea there may then have been in the North Atlantic; but, unlike its Triassic predecessor, it was separated from the Pacific by a broad belt of land.

In the succeeding Cretaceous period we get the last geological proof of an Arctic Ocean before that of the existing period. The sea had receded in the Old World, but it had gained considerably in America; for marine Cretaceous deposits occur in Central British North America, and the sea seems to have entered that area by the Mackenzie River depression. In the Tertiary era all the positive evidence relates to land conditions, excepting some obscure fossils in one or two localities, and some patches of Miocene shell-beds bordering the Pacific, as on the shores of the sea of Okhotsh. The Arctic Ocean therefore appears to have shrunk very considerably, and the land areas to have once again broken up the basin of the northern sea.

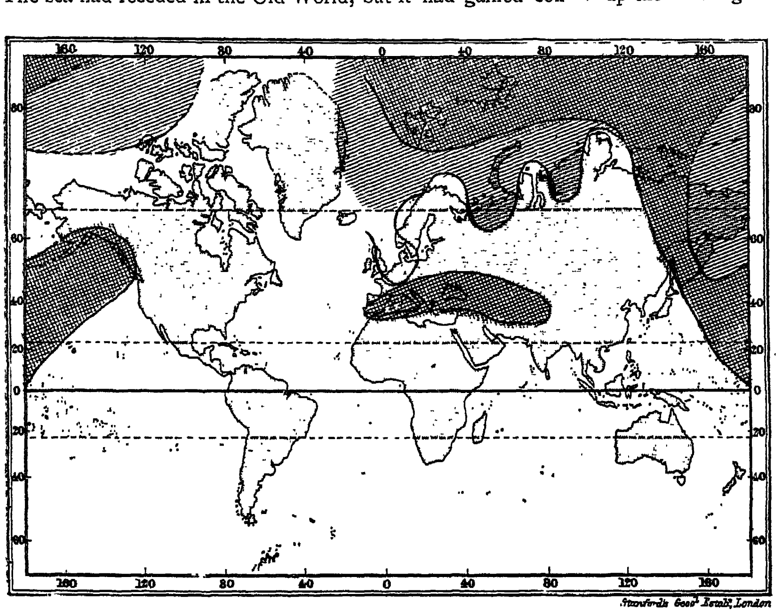

FIG. 3.—The Northern Seas in the Trias (cross-hatched) and Upper Jurassic (lined tint). [In Eastern Asia, the lined area should not come south of the broken line in lat. 75°.]

A general summary, therefore, of the facts of Arctic geology show that the Arctic Ocean has varied greatly, both in position and size. The Arctic Basin is at the present time bounded by a rim of land which is supported by five great blocks of Archean rocks; these blocks form, respectively, Scandinavia and North-western Russia; Labrador and North-eastern British America; Greenland; Alaska and North-eastern Asia; and the Archean block of Central Siberia. These Archean blocks were each more or less completely surrounded by bands of sedimentary rocks. At least two of them have never been below sea-level; and there is no satisfactory evidence to prove that the other blocks have been submerged, at least, since Middle Palæozoic times. In fact, the geological history of the Arctic Basin is the record of the alternate enlargement and diminution of the Arctic seas by the elevation and depression of parts of the bands of sediments, which surround the Archean blocks. The blocks themselves are of great geological antiquity, and the successive earth movements have been moulded upon them. As the main nuclei of the great land masses of the Arctic regions are therefore of vast antiquity, it may be thought only reasonable to assume an equally great age for the central ocean basin. But if we look at a map of the Polar regions showing the strike of the rocks and the trend of the mountain chains, we see that these all run north and south, and end abruptly on the margin of the Polar Basin. This meridianal trend occurs in the branch of the Rocky Mountains that forms the western boundary of the Mackenzie River, in the Archean axes of Boothia and Melville Peninsula, in the strike of the rocks of Northern Greenland and Western Spitzbergen. In Asia it is particularly well shown by the Ural and Verkhanoysk Mountains and their respective geological continuations, Nova Zemlya and the New Siberian Islands, and by the parallel chains between the Lena and Behring Straits.

Analogy with similar truncated mountain lines elsewhere renders it probable that all the mountain ranges, having what von Tol calls a "Ural orientation," once extended further to the north. If they did so, they would have effectually broken up the existing Polar Basin. At the present time our knowledge is insufficient for a final conclusion. But the evidence of the historical geology, physical structure and earth movements of Arctic lands are all consistent with the origin of the Arctic Basin as a great area of subsidence (a "senkungsfeld" of Suess) later than the deposition of the lower Tertiary plant beds. The geological facts attest such great geographical changes in that region, that geologists are not at present bound to abandon helpful explanations, which are in themselves probable and are in harmony with the geological evidence, simply because they may be inconsistent with the permanence of the Arctic Basin. J. W. GREGORY.

SCIENTIFIC INVESTIGATIONS OF THE SCOTTISH FISHERY BOARD.

THE third part of the Fifteenth Annual Report of the Fishery Board for Scotland, dealing with the principal scientific investigations conducted under the auspices of the Board in 1896, has just been published. The work done may be judged from the subjoined summary, which is abridged from the general statement prefixed to the detailed reports on the investigations carried out.

In the course of the year, the investigations which were carried on under the supervision of the Scientific Superintendent, Dr. Wemyss Fulton, were prosecuted on the same general lines as in previous years, and have resulted in further extensions of knowledge respecting the life-history and habits of the food fishes, and by the physical conditions and changes in the sea which bear upon fishery problems. Special attention was given to certain hydrographical questions concerning the circulation of the water in the North Sea and the adjacent parts of the North Atlantic. In addition to such inquiries, the hatching and artificial propagation of some of the important food fishes have been continued at the Board's Marine Hatchery at Dunbar.

One of the most important results of the work has been to show that the food fishes which form the basis of the fishing industry—such as plaice, cod, haddock, ling, turbot, &c.—do not spawn on the east coast within the three-mile limit, as was previously supposed. On the other hand, it is not known at what distances from the shore or in what precise localities the spawning areas are chiefly situated. It would obviously be of great advantage to obtain accurate information on this subject, and to be able to map out on a chart the regions where the various species of the food fishes spawn.

The Influence of Beam Trawling.

The results of the trawling experiments carried on in 1896, together with the tables embodying the details of the observations, are given in a special report. The trawling experiments have for the present been suspended in the Firth of Forth and St. Andrews Bay, where they were most systematically and regularly conducted for a number of years. The general results, so far as concerns the most important subject of the experiments in these waters, the increase or decrease in the abundance of the food fishes since beam trawling was prohibited, showed that while the relative numbers of most of the round-fishes, such as cod and haddock, and the unimportant flat-fishes, the dabs, had slightly increased, there was a decrease among the more valuable flat-fishes, the plaice and lemon sole, a circumstance probably due to the increased trawling in the offshore areas where these fishes spawn.

The Hatching and Rearing of Food Fishes.

In previous reports, detailed descriptions were given of the methods and processes adopted at the Dunbar Hatchery in connection with the artificial propagation of marine food fishes. Operations have been conducted for the most part with the valuable flat-fishes, especially the plaice, but also the turbot, sole, and lemon sole, and also on a lesser scale with certain round-fishes, such as the cod and haddock. The total number of the various species which have been hatched and placed on the fishing grounds since the work was begun in 1894 is 92,920,000.

During the current season (1897) the artificial propagation of plaice is being proceeded with on a large scale, but owing to the earlier publication of the annual report this year, it was not possible to give a statement of the results of the work, which is still in progress. As mentioned in last year's report, the fry produced in the hatchery are being transferred to certain sea-lochs, which are, to a large extent, cut off from free communication with the open sea, and observations are being made to test the results on the relative abundance of the same species within the areas selected.

The hatching work has hitherto been much impeded by the want of suitable ponds or enclosures of sea-water in which the adult spawners could be retained from one season to another, and by means of which it would be possible to retain the fry until towards the close of the post-larval stage, when they begin to assume the form and habits of the adult, and are in a much better condition to successfully meet the influences tending towards their destruction. The present report contains a paper by Mr. Harald Dannevig, giving the results of experiments he has made with the view of ascertaining the methods by which this may be accomplished. Some of the fry of the plaice which were hatched in the establishment were kept in suitable vessels of unfiltered water, to which tow-net collections—that is to say, the gatherings of minute organisms found naturally in sea-water—were added. By this means the fry were reared through their post-larval stages, until they had undergone their transformation into little plaice and settled on the bottom. Their food consisted to a small extent of diatoms, and chiefly of minute crustaceæ and larval molluscs.

These experiments point to a method by which the utility of artificial propagation might be considerably extended, namely, by retaining the fry for a few weeks in suitable enclosures of sea-water before they are transferred to the sea.

The Currents in the North Sea and their Relation to Fisheries.

In recent years, the attention of a number of investigators has been directed to the hydrography of the North Sea, and several inquiries and series of observations have been made with the object of determining its principal physical conditions with especial relation to the movement of its waters. During the last two years and a half some thousands of drift-bottles have been thrown into various parts of the North Sea, about five hundred of which have been recovered, and from careful comparison of the course taken, combined with a study of the prevailing winds throughout the period, it has been possible to ascertain the general circulation of the surface water. The results are given in a paper in the present report by Dr. Wemyss Fulton, who shows (1) that surface water passes into the North Sea from the Atlantic round the north of Scotland and in the neighbourhood of the Orkney and Shetland Isles, and then moves southwards along the east coast of Scotland and England to the neighbourhood of the Wash; (2) that it then travels in an easterly direction towards the coast of Denmark, and then northwards to the Skagerak, which it may or may not enter, and finally passes northwards along the west coast of Norway, at least as far as the Loffoden Islands.

Drift-bottles were found scattered along a stretch of about 1700 miles of coast, in Scotland, England, Holland, Germany, Denmark, Sweden, and Norway, between 53° and 69° N. latitude.

A detailed study of the winds prevailing during the time the experiments were in progress, based upon over 12,000 observations, appears to show that this circulation of the surface water in the North Sea is principally due to the preponderance of south-westerly and westerly winds, which tend to heap up the surface water on the western or continental coasts, when, as it cannot escape southwards owing to the shallows and the narrow orifice of the Channel, it passes to the north; but subsidiary influences may aid the movement. For some weeks last winter, owing to prolonged gales and strong winds, first from a south-easterly and then from a north-easterly direction, the circulation was reversed, the surface water passing rapidly northwards along our east coast, from Norfolk to the Shetlands.

The main object of the experiments was to determine the part taken by the surface currents in transporting the floating eggs and larvæ of the food fishes from the great spawning areas lying off the coast to the territorial waters and inshore grounds. It is shown that as the normal current moves along our east coast in a southerly direction at a mean rate of about two or three geographical miles a day, and as the floating eggs, according to the species and the season, take from about a week to over three weeks to hatch, and the larvæ are exposed for some weeks additional to the action of the current, they may be carried for very considerable distances from the place where they are spawned.

From a study of the mean temperature of the surface waters off the east coast of Scotland in each month throughout the spawning season, namely, from January to August, and of the duration of the development of the embryonic fishes within the eggs of the various species at such temperature, it is shown that the spawning grounds of early spawners, as the cod, haddock, and especially the plaice, may be normally situated more than fifty or sixty miles to the north of the locality where the young fishes are found. With summer spawners, on the other hand, whose eggs develop with much greater rapidity, owing to the higher temperature of the surface waters, the distance between the spawning area and the "nurseries" of the young fishes is much less. The spawning areas off a particular part of the coast do not normally supply the inshore waters opposite to them, but those situated further south; thus, for example, the breeding grounds off the coasts of Forfarshire and Kincardine stand in relation to St. Andrews Bay and the Firth of Forth, while the breeding grounds situated to the east of the latter stand in relation to the coasts of Berwickshire and Northumberland.

It is shown that the southward drift of the floating eggs and larvæ of the plaice is in agreement with the migratory movement of the adults and growing fish, which is in the opposite, or northerly, direction.

The easterly surface drift from the neighbourhood of the Dogger Bank also tends to explain the enormous aggregation of immature flat-fishes in the great bight between the north coast of Holland and the coast of Denmark. The southerly drift is not improbably related to the movements of the herring shoals during summer and autumn, but the connection has not yet been thoroughly investigated.

The Life-Histories and Development of the Food Fishes.

Prof. M'Intosh describes the life-histories of the cod, haddock, and whiting from very early stages. It is shown that, while the spawning grounds of the cod are offshore, the eggs and larvæ are wafted inshore, or that the post-larval stage is attained in the former region, the young fish moving shorewards subsequently, when from about half an inch to three-quarters of an inch in length. During June and July they frequent the shallow rock-pools at ebb-tide in company with the green-cod or saithe, and as they grow older many of them pass outwards again to the off-shore waters. Young haddocks have a different distribution from the young cod, and are found in the deeper water at a distance from shore, as appears also to be the case with the

younger stages of the whiting. The appearance and diagnostic characters of the various stages, which have frequently been difficult to distinguish in the past, are described very fully, and are illustrated by a series of figures.

THE DISTRIBUTION OF PELAGIC EGGS.

Mr. A. T. Masterman furnishes a review of the work done by the *Garland* in connection with the distribution of the pelagic eggs of food fishes in the years 1890–96, with special reference to the determination of the spawning areas and seasons of the various species and the direction taken by the eggs after they are shed. The observations made in the Firth of Forth and St. Andrews Bay throughout the above period are brought together and compared, lists being furnished of the principal species dealt with. The more important conclusions drawn from the study of the distribution of the pelagic eggs agree with those previously derived from the investigations into the distribution of spawning adults, namely, the season at which the various species spawn, and the place where the eggs are shed. It is shown that the more valuable forms, such as the cod, haddock, plaice, coal-fish, turbot and ling, spawn outside the three-mile limit, the floating eggs appearing first at the seaward stations and being gradually drifted in; on the other hand, less important species, such as the gurnard, flounder, and dabs, spawn within the limit as well as beyond it, and the sprat spawns principally within the limits of the Firth of Forth.

THE REARING OF LARVAL AND POST-LARVAL PLAICE AND OTHER FLAT-FISHES.

In connection with the artificial propagation of the food fishes a series of experiments were made by Mr. H. Dannevig in the rearing of the young fishes derived from the artificially fecundated eggs, which have yielded results of scientific interest. The natural food of the early post-larval plaice has been determined, and also the duration of the larval and post-larval periods. It was found that the larvæ from plaice eggs which were fertilised on April 28 and hatched on May 10, took eight days to absorb the yolk and enter on the post-larval stage, and other thirty-four days, or forty-two days from the date of hatching, before they settle permanently on the bottom as typical little flat-fishes. The changes during their development are described and illustrated in a plate.

MARINE DIATOMS.

Mr. George Murray, F.R.S., Keeper of the Department of Botany of the British Museum, conducted on board the *Garland* during part of the year an investigation into the distribution and reproduction of diatoms and minute floating vegetation found in the sea, which form an important constituent of the food of minute crustaceans and of fishes in their very early stages. In the paper describing the results it is pointed out that during the first months of the year there is a remarkable prevalence of diatom life in the sea off both the east and west coasts, the quantity diminishing towards the end of March, and thereafter remaining at a fairly constant minimum. The part taken by these minute vegetable forms in furnishing food for crustacea and young fishes is described, as well as the reproductive processes of the diatoms, respecting which the observations have been of great scientific importance.

Prof. Cleve, of Upsala, Sweden, also contributes a paper to the report, describing the characters and distribution of the diatoms and minute plant-life collected by tow-nets in the Faroe-Shetland channel during the expedition of H.M.S. *Research* to that region in August last year. The chief object of the inquiry was to determine, by comparison of the abundance and distribution of minute floating organisms, the movements of the water towards and from the North Sea.

THE INVERTEBRATE FAUNA.

Mr. Thomas Scott contributes to the report a paper describing the invertebrate fauna, as well as the fishes, of Loch Fyne, and furnishing lists of all the species which have been found in that loch, together with notes of their distribution. An account is also given of the parasites of the common copepod, *Calanus finmarchicus*, which forms an important constituent of the food of fishes. In another paper Mr. Scott gives the results of his continued investigations on the invertebrate fauna of the inland waters of Scotland, including that of several lochs in Cantyre, Bute, and Forfarshire, as well as of Shetland, in the examination of which he was assisted by Mr. Robert Duthie. Through these investigations some important additions have been made to the fresh water fauna of Scotland. In a third paper the invertebrate fauna, collected by tow-nets used on board H.M.S. *Research* in the Faroe-Shetland Channel, in August, is described, notes being furnished showing the distribution of the various species obtained.

PHYSICAL INVESTIGATIONS.

In addition to the regular determinations of the temperature and density of the sea water at various stations by the *Garland*, special physical investigations were made last year in the Faroe-Shetland Channel and in Loch Fyne. By the courtesy of Admiral Wharton, the Hydrographer to the Admiralty, a series of temperature observations were taken in the former area by the officers of H.M.S. *Research*, under the command of Captain Moore, and a large number of samples of water were secured from various depths for the subsequent determination of the density. Mr. H. N. Dickson has prepared a special paper on the subject, which is printed in the present report. The work was undertaken with the view of forming part of the continued hydrographic survey of the North Sea and the North Atlantic, instituted as an international scheme with Sweden, Denmark, Norway, and Germany in 1893, and the observations made on board H.M.S. *Research* form an important contribution to the subject. The observations in Loch Fyne and the Firth of Clyde were made by Dr. H. R. Mill in April and September, and are dealt with in another paper. They serve to confirm the previous conclusions as to the circulation of the waters in Loch Fyne.

THE PHYSIOLOGY OF THE EMOTIONS.[1]

THE respiratory movements have wide-reaching effects. They not only lead to the flow of air to and from the lungs, but they profoundly influence the circulation of the blood and lymph; they also affect the functions of the abdominal and pelvic viscera by rhythmically compressing and dislocating them. Now, these movements are liable to constant modification in the physiological acts of talking, shouting, singing, laughing, crying, sighing, and yawning (as also in the occasional and semi-pathological acts of sneezing, coughing, vomiting, and hiccoughing), and it therefore follows that these acts are more far-reaching in their effects than would at first sight appear, and hence are worthy of our careful study. This will the more readily be granted when it is added that they affect the body, not only by modifying the respiratory movements and thus producing the effects already mentioned, but by involving the expenditure of a considerable amount of neuro-muscular energy, and by inducing definite psychic phenomena which themselves have their physical accompaniments.

Seeing, then, how far-reaching are the effects of these several acts, and remembering how large a part they play in normal life, we may safely conclude that they influence the functions of the body beneficially, and that an undue interference with them is injurious. One is apt to forget how strong is the instinct to shout and sing, laugh and cry. It is especially noticeable in the savage and in the child. If these instincts are unduly repressed in the child he is sure to suffer. Crying should certainly be restrained within limits, but there can be no doubt that it is primarily physiological, not only favouring the proper expansion of the lungs and accelerating the circulation, but deadening the effects of pain and relieving nerve tension (especially in woman). Rosbach thinks it not improbable that many evils which manifest themselves in later life, such as chlorosis, contracted chest, and the phthisical habit, "may take their origin in the practice of mothers to stop their infants from screaming by soothing them to sleep in their arms or by stupefying rocking in the cradle." (Von Ziemssen's "General Therapeutics," vol. iii. p. 581). It is well known that children show a strong instinct to chatter and sing the first thing in the morning, and it should be allowed full vent as far as is practicable. The shouting which young people indulge in during their play is quite remarkable and is manifestly physiological. The same tendency to shout is observed in young adults, especially among the poorer classes in holiday time. Though from the physiological point of view justifiable, and even

[1] "The Therapeutical Aspects of Talking, Shouting, Singing, Laughing, Crying, Sighing, and Yawning." By Dr. Harry Campbell. (Abridged from *The Lancet*, July 17.)

beneficial, the noises they make are certainly not always pleasing, especially to the sensitive nerves of the cultured, amongst whom this instinct is consequently suppressed, though whether altogether to the gain of the individual is questionable.

The various acts referred to will now be considered individually.

TALKING.

As regards the psychic aspect of talking, thought becomes much more vivid if it finds expression, whether in speech, writing, music, or artistic production, than if it remains unexpressed. The physical effects of thought are more pronounced in talking than in writing. The cortical nervous discharges underlying it send a stream of energy towards the muscles involved in speech and gesture, and both voice and gesture can be modified to convey subtle shades of thought and feeling which cannot find expression in writing. The very expression of these refinements enhances the vividness and intensity of mentation. Talking is for this reason stimulating, and its influence in this respect is in a measure proportional to the gesture accompanying it. Few things are more calculated to stimulate the body, to rouse it from lethargy, than "animated" conversation. In talking, as in laughing, shouting, singing, and crying, inspiration is short, while expiration is prolonged, the exit of air being checked partly by obstruction in the glottis and partly, perhaps, by the action of the inspiratory muscles. The actual amount of work done in talking is far more than might at first sight be supposed, and should always be taken into account in reckoning up the quantity of exercise taken during the day. The amount of talking done by barristers, politicians, and others enables them to dispense largely with exercise as ordinarily understood; for not only do they in this way expend a considerable amount of muscular energy, but they experience the manifold advantages of active respiratory movements continued for long periods together; indeed, I believe talking to be distinctly conducive to longevity. That talking involves a considerable expenditure of energy is shown by the exhaustion which it induces in those who are nervously run down. Such are often greatly exhausted, even after a moderate day's talking. This exhaustion is due to mental as well as to muscular expenditure; indeed, in the very neurasthenic the bare process of thought may be an effort and the mere effort to think may alone cause exhaustion; and if such is the case, how much more likely is the putting of thought into speech to do so, seeing that, apart from the muscular expenditure involved in speech, thought is so much more intense when spoken than when unexpressed. Talking is a beneficial exercise in heart disease, especially in those forms in which the blood tends to be dammed back upon the lungs. The good effect is here doubtless due to the increased amplitude of the respiratory movements and to the help thus afforded to the pulmonary circulation. It is for this reason that I always encourage talking in those suffering from passive engorgement of the lungs. "The breathlessness due to dilatation of the heart," observes Sir William Broadbent, "is often relieved by exercise of the voice. I have met with numerous instances in which a clergyman has climbed into the pulpit with the utmost difficulty, and has not only preached a sermon comfortably, but has been all the better for it" (*The Lancet*, April 4, 1891, p. 798). The good result, I take it, in these cases is attributable to the deep inspirations required by the loud voice necessary to fill a large building.

SHOUTING.

The psychic accompaniment of shouting is essentially emotional. Emotion is not only expressed, but sustained, and, indeed, intensified by it. Thus the shouting of children at play, itself the outcome of exuberant emotion and pent-up neuromuscular energy, enhances the emotional outburst. In like manner the hurrahs of an applauding multitude, the cry of the huntsman, the war-whoop of the savage, the yells of an attacking force, may so exalt emotionality as to induce a condition bordering on ecstacy. A further effect of shouting is to dull sensibility, the emotional exaltation which it provokes, and the voluminous discharge of neuro-muscular energy accompanying it, inducing a corresponding depression in the sensorial sphere. It is on this principle that groaning, and still more the shriek of acute agony, bring relief. The mere sound produces a similar effect by violently energising the acoustic centres.[1] The shouting and gesticulation which accompany an outburst of passion act physiologically by relieving nerve tension; and, indeed, as Hughlings Jackson has suggested, swearing may not be without its physiological justification. Passionate outbursts are generally succeeded by a period of good behaviour, and, it may be, improved health. One frequently notices this in children, and I have also observed it in the adult. It is possible that the outbursts of irritability observed in disease, as, for instance, in gout, have their physiological as well as their pathological aspect. As regards the modifications in the respiratory movements caused by shouting, the important practical point to notice is that they are increased in depth. Hence shouting favours the development of the lungs and accelerates the circulation of blood and lymph.

SINGING.

Singing, like shouting, is more emotional than intellectual, the degree of emotion called forth depending upon the extent to which the individual throws himself into the spirit of the song. The nature of the attendant emotion varies of course considerably, and there is a corresponding variability in its physical correlatives: if the theme of the song be joyous the proper rendering of it is highly stimulating. From the medical standpoint singing is a most important exercise, both by virtue of its influence on the emotions, on the respiratory movements, and on the development of the lungs. The good average health enjoyed by professional singers is in large measure attributable to the mere exercise of their calling.[2] Such therapeutic importance do I attach to singing that I recommend it wherever opportunity affords. It is especially useful in defective chest development and in chronic heart disease. Oertel speaks enthusiastically of the beneficial influence of singing on the general health, and especially on the lungs, and he refers to the fact that almost all eminent singing masters can tell of serious cases of lung disease which have been cured by their method of singing. He thinks there can be no doubt that weak chests of various kinds can be greatly improved by it, and he would even appear to include phthisis.

LAUGHTER.

The psychic accompaniment of laughter being joyous emotion, its effect is stimulating, and it has been truly said that the man who makes us laugh is a public benefactor. Its beneficial effect on the body is illustrated by the saying, "Laugh and grow fat." The expiratory act in laughter is greatly prolonged, and, the glottis being partly closed, intra-pulmonary tension is increased; and thus in excessive laughter there may be considerable impediment to the flow of blood through the lungs, as shown by the turgid head and neck. This disadvantage—for in most cases of heart disease it is a disadvantage—is far more than compensated for by other effects, foremost among which must be reckoned the deep inspirations which separate the individual paroxysms.

CRYING.

In thinking of the term "crying," one must distinguish between the mere shedding of tears, and weeping accompanied by sobbing. In the one the effects are limited, while in the other the entire body may be convulsed. I have already referred to the beneficial effects of crying in children. The crying of the infant is peculiar. Expirations are prolonged sometimes for as much as half a minute, and are interrupted by short inspirations. During the expirations the glottis is contracted, and the intrapulmonary pressure rises considerably. Not only is the pulmonary circulation thereby greatly impeded, as shown by the swollen veins of the head and neck, but bronchial mucus, flatus, and other noxious matters are evacuated. The paroxysm is succeeded by rapid deep respirations, which restore the equilibrium of the circulation. Women likewise often derive benefit from "a good cry"—the profuse flow of tears lessens blood-pressure within the cranium; the voluminous discharge of nerve energy relieves nerve tension; the sobbing movements of respiration influence in a very decided and doubtless beneficial way the circulation and the movements of the abdomino-pelvic

1 A famous quack extracts his patient's teeth to the blare of trumpets and the boom of the big drum.

2 The splendid chest development of public singers is, of course, not entirely attributable to the constant exercise of the voice, since no one can attain a high excellence without having a good chest development in the first instance. It must also be observed that every singer who attains to fame is careful to lead a healthy life.

viscera; while the widespread contraction of the muscle system has probably also a good effect. How pronounced are the dynamic effects induced by completely abandoning oneself to a fit of crying is shown by the exhaustion which it entails. It is partly through this exhaustion that crying induces sleep; we hear of "crying oneself to sleep," though this must be but a very crude explanation of the phenomenon. The tendency of women to cry should, of course, be kept within proper bounds, but certainly harm may result from its complete suppression, as Tennyson recognises in the line—

"She must weep or she will die."

It is said that women who are able to find relief in tears keep their youth longer than those who repress them. The internal cankering action "like a worm i' the bud" of pent-up emotion is not only a beautiful poetic conceit, but a profound physiological truth. In short, strong emotion should receive expression—"give sorrow words."

SIGHING.

"A sigh is a deep thoracic respiration, with retraction of the abdomen."[1] The retraction of the abdominal muscles leads to a compression of the splanchnic veins. This compression is probably increased by slight descent of the diaphragm. The blood is thus pressed out of those veins into the right heart, and the flow into this chamber is further favoured by the deep inspiration which also aids the circulation through the lungs. A more common cause of sighing I believe to be shallow breathing, however induced. Thus sadness and a sense of weariness or boredom are wont to be attended by shallow breathing, and in all of them sighing is frequent. In consequence of this shallow breathing, blood-aeration lags behind, and the blood tends to accumulate in the right heart and systematic veins. The sigh benefits by promoting the aeration of the blood and quickening the pulmonary circulation, and it is for similar reasons that sighing is apt to occur during a state of "breathless attention"—when the attention, *i.e.*, is so strained that one forgets, as it were, to breathe adequately.

YAWNING.

There can be little doubt that one of the objects of yawning is the exercise of muscles which have been for a long time quiescent, and the acceleration of the blood and lymph flow which has, in consequence of this quiescence, become sluggish. Hence its frequency after one has remained for some time in the same position—*e.g.* when waking in the morning. Co-operating with this cause is sleepiness and the shallow breathing which it entails. This factor, as well as muscle-quiescence, is apt to attend the sense of boredom which one experiences in listening to a dull sermon. Hence it is that the bored individual is apt to yawn. As in the case of sighing, the deep breath which accompanies the act of yawning compensates for the shallow breathing, which is so apt to excite it.

[1] L. Hill: *Journal of Physiology*, vol. xv. p. 48.

ON THE ASCENT OF WATER IN TREES.[2]

WITHIN the last few years the problem of the ascent of water has entered on a new stage of existence. The researches which have led to this new development are of such weight and extent that they might alone occupy our time. It will be necessary therefore to avoid, as far as possible, going into ancient history. But it will conduce to clearness to recall some of the main stepping-stones in the progress of the subject.

The two questions to be considered are: (1) What is the path of the ascending water? (2) What are the forces which produce the rise?

(1) The first question has gone through curious vicissitudes. The majority of earlier writers assumed that the water travelled in the vessels. This was not, however, a uniform view. Cæsalpinus, 1583, seems (Sachs' "History of Botany," English Trans., p. 451) to have thought that water moved by imbibition in the "nerves." Malpighi and Ray held that the vessels serve for air, and the wood fibres for the ascent of water. Hales ("Vegetable Staticks," p. 130), who believed in the "sap-vessels" as conduits, speculated on the passage upwards of water between the wood and the bark. Also (*loc. cit.* p. 19), that water may travel as vapour not in the liquid state. In the present century Treviranus (Sachs' "History"), 1835, held that water travelled in vessels; De Candolle, 1832, that the intercellular spaces were the conduits. In Balfour's "Manual of Botany," 1863, vessels, cells, and intercellular spaces are spoken of as transmitting the ascending water.

[2] A paper read before Section K of the British Association at the Liverpool meeting, by Francis Darwin, F.R.S. (Revised January 20, 1897).

The change in botanical opinion was introduced by the great authority of Sachs,[1] who took up Unger's view[2] that the transpiration current travels in the thickness of the walls as water of imbibition.

Then followed the reaction against the imbibitionists—a reaction which has maintained its position up to the present time. Boehm, who had never adopted the imbibition theory, must have the credit of initiating this change; his style was confused and his argument marred by many faults, but the reaction should in fairness be considered as a conversion to his views, as far as the path of the travelling water is concerned. Nevertheless, it was the work of others who principally forced the change on botanists—*e.g.* von Höhnel (*Pringsheim's Jahrb.* xii., 1879), Elfving (*Bot. Zeitung*, 1882), Russow (*Bot. Centr.* xiii., 1883), R. Hartig ("Ueber die Vertheilung," &c., *Untersuchungen aus dem Forst. Bot. Inst. zu München*, ii. and iii.), Vesque (*Ann. Sc. Nat.* xv. p. 5, 1883), Godlewski (*Pringsheim's Jahrb.* xv., 1884), and others.

(2) The second question has a curious history, and one that is not particularly creditable to botanists generally. It has been characterised by loose reasoning, vagueness as to physical laws, and a general tendency to avoid the problem, and to scramble round it in a mist of *vis à tergo, capillarity, Jamin chains, osmosis*, and *barometric pressure*.

An exception to this accusation (to which I personally plead guilty) is to be found in Sachs' imbibition theory, in which, at any rate, the barometric errors were avoided, though it has difficulties of its own, as Elfving has pointed out.

But the most hopeful change in botanical speculation began with those naturalists who, concluding that no purely physical causes could account for the facts, invoked the help of the living elements in the wood. To Westermaier (*Deutsch Bot. Ges.* Bd. i., 1883, p. 371) and Godlewski (*Pringsheim's Jahrb.* xv., 1884) is due the credit of this notable advance, for whether future research uphold or destroy their conclusions, it claims our sympathy as a serious facing of the problem by an ingenious and rational hypothesis.[3]

We may pass over the cloud which arose to witness for and against these theories, and proceed at once to Strasburger's great work (*Leitungsbahnen*, 1891), in which, with wonderful courage and with the industry of genius, he set himself to work out the problem *de novo*, both anatomically and physiologically. In my opinion it is difficult to praise too highly this great effort of Strasburger's.

Strasburger's general conclusion is now well known. He convinced himself that liquid can be raised to heights greater than that of the barometric column in cut stems, in which the living elements have been killed. Therefore, the cause of the rise could not be (1) barometric pressure, (2) nor root pressure, (3) nor could it be due to the action of the living elements of the wood. His conclusions may be stated as follows:—

(*a*) The ascent of water is not dependent on living elements, but is a purely physical phenomenon.

(*b*) None of the physical explanations hitherto made are sufficient to account for the facts.

Strasburger has been most unjustly depreciated, because his book ends in this confession of ignorance. I do not share such a view. I think to establish such distinct, though negative, conclusions would be, in this most nebulous of subjects, an advance of great value. Whether he has established these conclusions must of course be a matter of opinion. To discuss them both would be to go over 500 pages of Strasburger's book, and will not here be attempted. Conclusion (*a*) that the ascent is not dependent on living elements must, however briefly, be discussed, because it is here that the roads divide. If we agree with Strasburger, we know that we must seek along the physical

[1] *Physiol. Végétale* (French Trans.), 1868, p. 235, and more fully in the *Lehrbuch*. Sachs also partially entertained Quincke's well-known suggestion of movement of a film of water on the surface of vessels.

[2] *Sitz. k.k. Akad. Wien*, 1868. Dixon's and Joly's paper in the *Annals of Botany*, September 1895, gives evidence in favour of a certain amount of movement of the imbibed water.

[3] It is of interest to note that Hales, in speaking of the pressure which he found to exist in bleeding trees, says: "This force is not from the root only, but must also proceed from some power in the stem and branches." ("Veg. Staticks," 1727, p. 110.)

line; if we differ from him, we are bound to seek for the missing evidence of the action of the living elements.

Schwendener's Criticism.—Perhaps the best plan will be to consider the most serious criticism that has been published of Strasburger's work, namely Schwendener's paper "Zur Kritik," &c. (*K. Preuss. Akad.* 1892, p. 911).

Schwendener objects that although a continuous column of water cannot be raised by air pressure to a greater height than that of the barometric column, yet when broken into a number of columns, as in the case of a Jamin chain, that a column considerably over 10 m., even as much as 13 or 14 m., of water can be suspended. This, though not fatal to Strasburger's conclusions, is no doubt a serious criticism. For if 13 m. can be supported, some of Strasburger's experiments are inconclusive. He finds that a branch can suck up a poisonous fluid to over 10 m., and, as above explained, argues that all ascent above that height, not being due to barometric pressure or to the living elements (since the wood is poisoned), is for the present inexplicable. But, if Schwendener is right, the effect above 10 m. may have been due to atmospheric pressure. Askenasy (*loc. cit. infra*, 1895, p. 6) objects to Schwendener that the supposed action cannot be continuous. By repeating the diminution of air pressure at the upper end, the movement of water becomes less and less, and sinks to almost nothing. Askenasy adds, moreover, that the amount of water which could be raised according to Schwendener's theory would be very small.

One difficulty about Schwendener's theory is that the result depends on the length of the elements of which the chain is made up (such element being a water column, *plus* an air bubble.) In his paper "Ueber das Saftsteigen" (*K. Preuss. Akad.* 1886, p. 561), he finds that the elements of the chain in *Fagus* equal in round numbers 0·5 mm. In his paper (*K. Preuss. Akad. Sitz.* 1893, p. 842), "Wasserbewegung in der Jamin'schen Kette," he finds the element in *Acer pseudo-platanus* = 0·9 mm., in *Acer platanoides* and *Ulmus effusa* = 0·2. But the calculation (1892, p. 934) is based on the existence of a chain in which the water columns are each 10 mm. in length, a condition of things which he allows does not occur in living trees.

But even if we allow Schwendener to prove theoretically the possibility of a Jamin chain being raised to a height much greater than that of a barometric column, I do not think he invalidates Strasburger's position. Schwendener's idea necessitates the travelling of a Jamin chain as a whole, *i.e.* the translation not only of water, but of air bubbles. But this cannot (as Strasburger points out) apply to his experiments on conifers, in which the movement of air to such an extent is impossible ("Ueber das Saftsteigen," *Hist. Beiträge*, v. 1893, p. 50). And for the case of dicotyledonous woods, Strasburger has shown that the movement of air is excluded by the fact that transverse walls occur in the vessels at comparatively short distances. In Aristolochia the sections may be as long as 3 m., but in ordinary woods, according to Adler (as quoted by Strasburger), we get: Alnus, 6 cm.; Corylus, 11 cm.; Betula, 12 cm.; Quercus, 57 cm.; Robinia, 69 cm. These facts seem impossible to reconcile with Schwendener's views.

Action of the Poisonous Fluids in Strasburger's Experiments.—The question whether the living elements are killed in Strasburger's experiments is of primary importance in the problem.

Schwendener does not criticise it at length; he seems to assume (*Zur Kritik, loc. cit.*, 1892, p. 935)—as far as I can understand—that since the death of the tissues extends gradually from the cut end upwards, there are living cells in the upper part which may still be effective. He also doubts "whether the cells were always killed at once." The first objection of Schwendener's may or may not be sound, but in any case it does not (as Strasburger points out) account for the experiment (*Hist. Beitr.* v. p. 12) in which an oak stem was poisoned by picric acid, and three days afterwards was placed in fuchsin-picric. The second reagent had to travel in tissues already killed with picric acid, yet a height of 22 m. was reached.

The question whether the reagents kill the cells in Strasburger's experiments does not lend itself to discussion. It is difficult to see how they should escape, and we have Strasburger's direct statement that the living tissues were visibly killed. It must not be forgotten that in some of his experiments the death of the tissues was produced by prolonged boiling, not by poisons (*Leitungsbahnen*, p. 646). Thus the lower 12 m. of a Wistaria stem were killed in this way, yet liquid was sucked up to a height of 10S cm. In the *Histolog. Beitr.* v. p. 64, he has repeated his air-pump experiment, using a boiled yew branch, and found that eosin was sucked up from a vessel in which almost complete vacuum was established, so the action of living elements and of atmospheric pressure was excluded.

On the whole, the balance of evidence is, in my judgment, against the belief that the living elements are necessary for the rise of water. In other words, I think we should be justified, from Strasburger's work, in seeking the cause of ascent in the action of purely physical laws.

Strasburger's general argument from the structure of wood.—It seems sometimes to be forgotten that, apart from the physiological or experimental evidence, there is another line of argument founded on the structure of wood. Strasburger's unrivalled knowledge allows him to use this argument with authority, and he seems to me to use it with effect. Thus (*Hist. Beitr.* v. p. 17) he points out that though in coniferous wood the action of the living elements in pumping water is conceivable, yet this is far from being universally the case. He points out that in the monocotyledons such theories meet with almost unconquerable difficulties. This is, he says, especially the case in Dracæna. He goes on to point to difficulties in the case of such dicotyledons as Albizzia. The case may perhaps best be put in the generalised manner that Strasburger himself employs (*loc. cit.* p. 20). If the living elements are of such importance as Godlewski, Westermaier, and Schwendener hold, we ought not to find these difficulties; we ought rather to find structural peculiarities pointing distinctly to the existence of such functions. For instance, we ought to find the tracheal water-path actually interrupted by living elements, which might act like a series of pumping stations one above the other. It should, however, be remembered that if we deny the importance of the medullary rays and other living elements in raising water, we ought to be able to point more clearly than we can at present to the function of the medullary rays and to structural adaptations to these functions.

The work of Dixon and Joly and of Askenasy.—I now pass on to the recent work in which Strasburger's indications to search along a purely physical line have been followed. In the paper of Dixon and Joly (*Proc. Roy. Soc.*, vol. lvii. 1894, No. 340), the suggestion was for the first time made that the raising of water to the tops of trees depends on the quality which water possesses of resisting tensile stress. To most botanists the existence of this quality is a new idea. To believe that columns of water should hang in the tracheals like solid bodies, and should, like them, transmit downwards the pull exerted on them at their upper ends by the transpiring leaves, is to some of us equivalent to believing in ropes of sand. The idea is more fully treated in the *Phil. Trans.* vol. clxxxvi., and in the *Annals of Botany*, vol. viii. The same leading idea occurred independently to Askenasy, who has published it in the *Verhand. a. d. naturhist. med. Vereins Heidelberg*, N. F., Bd. v., 1895; and N. F., Bd. v., 1896.

Askenasy has earned the gratitude of his botanical readers by giving some of the evidence which demonstrates the existence of this property of water.[1] A tube a metre in length was filled by Donny with water, and the remaining space was as far as possible freed from air. When the tube was placed vertically, the water-column at the upper end hung there, and could not be made to break or free itself from the glass by violent shaking. Berthelot filled a thick-wall capillary tube completely with water at 28°–30° C.; it was allowed to cool to 18°, so that the space left by the shrinking of water was filled with air. It was then sealed up and again warmed to 28°–30°, so that the air was dissolved in the water. When it was allowed to cool again it retained its volume, filling the tube completely. A slight shake, however, allowed the water to break and return to its proper volume at 18° with the appearance of a bubble of air. In this experiment the water contained air, yet it seems to have been until recently assumed by some physicists that to show cohesion, water must be air-free. If this were the case, the application of the principle to plants would be impossible. Dixon and Joly have, however, proved that this is not so, and this forms an important part of their contribution to the subject.

They also[2] investigated the amount of tension which water under these circumstances will bear, and found it about equal to

[1] He gives reference to Donny, *Poggendorff's Annalen*, 67 Bd. (143. Bd. d. g. R.), 1846, p. 562; Berthelot, *Annales de Chimie et de Physique*, S. 3, t. 30, 1850, p. 232; Worthington, *Proc. Roy. Soc.* vol. l., 1892, p. 423.

[2] *Phil. Trans.* vol. 186, p. 570. With ethyl alcohol Worthington records a tension of 17 atmospheres. See *Proc. R. Soc.*, vol. l.

seven atmospheres. If, therefore, the leaves at the top of a tall tree can exert the requisite upward pull on the water in the trunk, it seems certain (if no other condition in the problem interfere) that the pull can be transmitted to the level of the ground. This opens up the question whether the leaves can exert this traction on the water in the tracheals, and what is equally important, Are there any factors in the problem incompatible with the theory?

(1) *The sucking force of the leaves.*—In Dixon and Joly's first paper (*Phil. Trans.* pp. 563, 567) they assume that tractional force is given by the meniscuses "formed in the membranous *réseau* of the evaporating cell-walls," as well as possibly by the osmotic action of the cells of the mesophyll. We shall take these theories in order. Our knowledge of the cell wall does not allow us to believe in the existence of pores visible with even the highest powers of the microscope. Dixon's more general expression (*Proc. Roy. Irish Acad.* Jan. 13, 1896, p. 767) "surface tension forces developed in the substance of the walls of the evaporating cells," is therefore preferable. But Askenasy seems to me to state the matter much more conveniently by using the term "imbibition" (*loc. cit.* 1895, p. 10). The force with which vegetable membranes, *e.g.* the thallus of Laminaria, absorb water, has been demonstrated by Reinke and others, and the existence of such a force is familiar to botanists.

Both Askenasy (*loc. cit.*) and Dixon and Joly (*Annals of Bot.*, September 1895) have pointed out that the force of imbibition, or the surface tension forces, as the case may be, can exert a tractional effect on the water in the tracheals, when the turgescence of the mesophyll has been destroyed. But Askenasy in his original paper (1895), Dixon in the January 1896 paper, and again Askenasy in his second paper (March 1896) have also considered the imbibitional or surface tension forces in connection with the turgescent cell. It must clearly be understood that this does not remove imbibition from the problem. The sun's heat causes the evaporation of the water with which the walls of the mesophyll cells are imbibed; this water is replaced by imbibition from the cell-sap. The concentration of the cell-sap so produced maintains the osmotic force of the cell, which again exerts suction on the water on the tracheals.[1]

I have now given, in its simplest form, the modern theory of the rise of water. Apart from the main idea, it combines the points of several familiar views. Imbibition becomes a factor of paramount importance, though not in the way that Sachs employs it. The suspended threads of water remind us of Elfving's capillary theory, while the living element factor is represented by the turgescent mesophyll cells.

Resistance.—It is not possible to discuss the question whether the tractional forces in the leaf are sufficient for the work imposed on them until we know what is the resistance to the passage of water through wood. For it is clear that the work done by the leaf includes not only the lifting of a given column, but the overcoming of the resistance to its flow.

The resistance to the flow of the transpiration current is in want of further investigation. Janse (*Pringsheim's Jahrb.* xviii., 1887, p. 1) has discussed the question, and points out (*loc. cit.* p. 36) that two kinds of resistance must be reckoned with. The first (which he calls statical) is illustrated by means of a cylinder of Pinus wood fixed to the short arm of a J tube filled with water, when it was found that in five days the level of water in the long arm was only one mm. above that in the short arm.[2] That is to say, when time enough is given, the resistance is practically nothing. Janse has also investigated the resistance to the passage of water flowing through wood at the rate of an ordinary transpiration current. His method seems to me open to criticism, but this is not the place to give my reasons. His experiments give a wide range of results. With *Pinus strobus* a pressure of water equal to ten times the length of the wood was required to force water through at a pace equal to the transpiration current. In Ginkgo the pressure was twenty-one times the length of the wood. Strasburger (*Leitungsbahnen*, p. 779) has repeated Janse's experiment, and finds a column "several times the length of the object" necessary. Nägeli ("Das Mikroskop," 2nd edit. p. 385) found that 760 mm. of mercury were needed to force water through fresh coniferous wood at the rate of $\frac{1}{20}$ mm. per second, *i.e.* at 180 mm. per hour. If we allow one metre per hour as a fair transpiration rate (Sachs' "Arbeiten," ii. p. 182), we get a pressure of 5 atmospheres required to produce such a flow. To return to Janse's experiments: even if we assume that the resistance (expressed in water) = 5 times the length, it is clear that with a tree 40 m. in height, the resistance of 20 atmospheres has to be overcome. This would not be a pressure greater than that which osmotic forces are able to exert, but when we come to a tree of 80 m. in height, and a resistance of 40 atmospheres, the thing becomes serious.[1] A great difficulty in the question of resistance is that the results hitherto obtained are (though here I speak doubtfully) much greater than those obtained by physicists for the resistance of water flowing in glass capillaries. Until this discrepancy is explained, it is rash to argue from our present basis of knowledge.[2]

[1] Sachs' "Text Book," edit. iv., Eng. Tr., p. 679, describes evaporation taking place in the cell wall, which makes good the loss by imbibition.

[2] Strasburger (*Leitungsbahnen*, p. 777) observed equilibrium established a good deal quicker.

Is the osmotic suck sufficient?—The osmotic force of a turgescent cell is usually measured by its power of producing hydrostatic pressure within the cell. Thus, De Vries ("Untersuchungen über d. mechanischen Ursachen der Zellstrecken," 1877, p. 118) investigated the force necessary to extend a plasmolysed shoot to its original length; Westermaier (*Deutsch. Bot. Ges.* 1883, p. 382) the weight necessary to crush a tissue of given area; Pfeffer (*Abh. k. Sächs. Ges.* 1893) the pressure exerted by growing roots; Krabbe (*K. Akad. Berlin* (*Abhandlungen*), pp. 57, 69, 1884) the pressure under which cambium is capable of maintaining its growth.

The figures obtained by these naturalists have a wide range; it may be said that the hydrostatic pressure varies between 3 and 20 atmospheres.

Another method is to ascertain the osmotic strength of the cell-sap in terms of a KNO_3 solution, and calculate the pressure which such a solution can produce. According to Pfeffer (Pfeffer, *Phys.* i. p. 53), 1 per cent. KNO_3 with artificial membrane gives a pressure of 176 cm. = 2·3 atmospheres. De Vries (*Pringsh. Jahrb.* xiv. p. 527) calculates that in a cell, a 0·1 equivalent solution (practically = 1 per cent.) gives a pressure of 3 atmospheres. We may therefore take it as between 2·5 and 3 atmospheres. Now, De Vries found that beetroot requires 6–7 per cent. KNO_3 to plasmolyse it; this would mean 15–21 atmospheres. I do not know what is the greatest pressure which has been estimated in this way. Probably Wieler's (*Pringsh. Jahrb.* xviii. p. 82) estimate of the pressure in the developing medullary ray cells of *Pinus sylvestris* at 21 atmospheres is the highest. It is clear that investigation of the osmotic capacity of leaves for high trees is wanted, also investigations of the variation in osmotic power produced by varying resistances in the flow of the current. The experiments of Pfeffer and others[3] show that the osmotic strength of cell-sap is capable of great adaptation to circumstances—cells respond by increased turgescence to various stimuli. Whether they can respond sufficiently to account for the ascent of water is another question.

My own opinion is that the question of resistance to the flow of water is a difficulty which the authors of the modern theory have not sufficiently met. Unless it can be shown that the resistance to the flow of water in wood is less than that indicated by existing researches, we must face the fact that we do not at present know of osmotic forces which we can suppose capable of raising water to a greater height than 40 metres.

Continuity of the water in the tracheals.—The theory we are considering apparently requires that there shall be continuous columns of water from leaf to root, because a break in the column means a collapse of the machinery. This seems at first sight a fair assumption, though I doubt its complete correctness. It is in any case worthy of discussion. It has been constantly insisted on by Sachs and others that at the time of most active transpiration the vessels contain air, and not water. It is therefore a violent disturbance of our current views to believe in continuous columns of water.

For evidence on this point we are chiefly indebted to Strasburger. It is a remarkable fact that he should, without any theory to encourage such a view, have come to the conclusion that approximate continuity of water columns is a condition of primary importance, and that he should have made out the cognate fact that the whole of the *alburnum* need not be simul-

[1] Schwendener's experiments, *K. Preuss Akad.* 1886, p. 579, do not particularly bear on this question.

[2] It is possible that the rate of the ascending water is much less than is usually assumed. Thus Schwendener (*K. Preuss. Akad.* 1886, p. 584) calculates from an observation of v. Höhnel that the transpiration current in the stem of a tall beech was only 2 metres per day.

[3] Pfeffer, "Abhand. der k. Sächs," *Ges.* xx. p. 300; Eschenhagen, *Untersuchungen aus d. Bot. Inst. z. Tübingen*, 1889; Stange, *Bot. Zeit.*, 1892.

taneously occupied by a transpiration current; parts of it may be so occupied, while parts of it are filled with air, and do not function as water-ways. This is a valuable contribution to knowledge, and to the adherents of the new theory it is priceless; the very existence of their hypothesis may depend on it.

Strasburger's statements and reasoning are by no means accepted by every one; for instance, Schwendener refuses to take them seriously (*K. Preuss. Akad.*, 1892, p. 931).

Strasburger has microscopically examined the condition of the tracheals as regards air.[1] He found in the spruce fir in July "almost no air bubbles" in the wood of the current year, but air in considerable quantity in four-year-old wood. In the same month *Pinus Salzmanni* (*Laricio*) showed scattered bubbles in the spring wood of last year, and more in the autumn wood. In a larch there were only very occasional bubbles in the two last years' wood. In the silver fir the current year's wood was practically free from air: the air increased in the inner rings. *Tsuga canadensis* had no air in this year's wood, only a little in last year's, and an increasing quantity in the older rings, the fifth being very rich in air. In February, *Pinus strobus* had hardly any air in this year's wood, and the silver fir was all but free from it in the youngest ring. Robinia in July had the youngest wood almost air-free. *Ficus elastica* and *spuria*, various *Acacias*, and willows gave vessels not entirely free from air, but nearly so. He concludes (*loc. cit.* p. 688) that the path of the transpiration current is not absolutely free from air. The younger wood, which especially functions as the water-carrier, is the most free.

Dixon and Joly quote Strasburger's results, which they consider sufficiently favourable to their views. They rely, in addition, on the impermeability of wet cell-walls to air, isolating the conduits in which air has appeared; and on the possibility that the air may be redissolved under root-pressure (*Phil. Trans.* p. 572), an idea well worth testing.

I think Strasburger's facts are not so favourable to their theory as these authors believe; in the same way it seems to me that Askenasy is rash in saying[2] that the tracheals in many cases contain continuous columns of water. It is true that this statement does not affect the validity of his general argument, since he faces the undoubted occurrence of air bubbles in many cases. This is undoubtedly necessary, and, fortunately, we can once more turn to the *Leitungsbahnen*. Strasburger states that he has seen water creep past the air bubbles (*Leitungsbahnen*, pp. 704, 709; see also "Hist. Beitr." v. p. 76) in coniferous tracheids. The best evidence for this seems to be the fact mentioned (*ibid.* p. 79), that the part of a single tracheid in front of an air bubble gets red with absorbed eosin, though the neighbouring tracheids are colourless. This clearly suggests the creeping round the bubble which Strasburger believes in. Schwendener (*Zur. Kritik*, &c., p. 921) has been unable to confirm Strasburger's microscopic observations, and, moreover, denies the physical possibility of the phenomena. I am unable to judge of the validity of Schwendener's theoretic objections, and must leave this point. It is a question of great importance whether it is possible that, on the breaking of a column of water, a film of water remains surrounding the air bubble, and capable of holding the two columns together. If this is impossible, we must suspend our judgment until we know more of the contents of the tracheals.

To sum up this part of the subject, we may believe that the tracheals in their youngest condition may contain water in continuous columns, since the cambium cells from which they arise certainly contain fluid. But we know also that this condition is not absolutely maintained, since Strasburger has shown that the young wood contains air, though in small quantity. We must, therefore, believe either (1) that the transpiration current is able to travel past the air bubbles, or (2) that tracheals partly filled with air may again become continuous water-ways by solution of the air. If we adopt the first alternative, we must believe that the film of water between the bubble and the wall of the vessel is able to bear such a tensile stress that it can serve to link the column above with the column below the bubble. But this is analogous to trusting a rope so nearly cut through that only a few threads remain intact. With regard to the second alternative, we have, at least, indications from Strasburger's work that a tracheal partly filled with air does not necessarily remain permanently functionless (see *Leitungsbahnen*, p. 692).

The isolation of the tracheals.—There are a number of points connected with the structure and properties of wood which ought to be considered in relation to the modern theories. Want of space forbids my doing more than referring to two of them.

The resistance which the wetted cell-wall offers to the passage of undissolved air is a point on which many writers have laid stress. It is clear that on any theory of the movement of water in the tracheals, it is essential that air should not filter into the water-way. This necessity is not, however, stronger in the case of the modern theories we are considering. The pressure tending to fill the tracheals with air from outside cannot be greater than atmospheric pressure, and since the wetted cell-walls of gymnospermous wood can resist the passage of air under a pressure of about an atmosphere,[1] we need not fear criticism of the theory on this ground. The above remarks seem, however, to be needed in face of the frequently recurring statement that wet wood membranes are impermeable to free air. Schwendener has some good remarks on this head (*Zur Kritik*, p. 943).

Strasburger has called attention to the important subject of the localisation or isolation of vessels, or of certain lines of tracheids. When this is possible we may have one set of tracheals containing continuous water columns, while neighbouring ones contain air at negative pressure (see *Histolog. Beiträge*, v. p. 87). This is especially important in connection with the Dixon-Joly-Askenasy theory, since, if there were no such isolation, a functioning tracheal containing a continuous column of water would give up its water to one which was not functioning. In other words, the inactive tracheals would, by negative pressure, suck water from the active ones. In the coniferous trees, the young wood is cut off by the absence of pits in the tangential walls[2] from free communication with the older wood, where air is more frequent.

In the same way the valve-like closure of the pits by the aspiration of the pit membrane, comes to be a subject of much importance.

At present I merely wish to show by a couple of examples the necessity of a complete study of the minute structure of wood in relation to the modern theories. It is, at least, a hopeful fact for Messrs. Dixon, Joly, and Askenasy that we cannot point to anything in the anatomy of wood which is absolutely inconsistent with their views. Finally, with regard to the question at large, whether we are friends or opponents of Messrs. Dixon, Joly, and Askenasy's theory, the broad facts remain that water has the power of resisting tensile strength, and that this fact must henceforth be a factor in the problem. There are difficulties in the way of our author's theory, but it is especially deserving of notice that many of these difficulties are equally serious in the case of any theory which excludes the help of the living elements of the wood, and assumes a flow of water in the tracheals. The authors have not only suggested a *vera causa*, but have done so without multiplying difficulties. There is, therefore, a distinct balance in their favour.

Huxley, quoting from Goethe, makes use of the expression *thätige Skepsis*. It is a frame of mind highly appropriate to us in the present juncture, if we interpret it to mean a state of doubt whose fruit is activity, and if we translate activity by experiment.

1 *Leitungsbahnen*, p. 683 *et. seq.*; Russow in 1882 (*Bot. Centr.*) vol. xiii. 1883) observed similar facts in the distribution of water and air.

2 *Verhand. Naturhist. med. Vereins Heidelberg*, 1895, p. 15.

1 *Leitungsbahnen*, p. 722. Nägeli and Schwendener, *Das Mikroskop*, 2nd edit. p. 367, give 225 cm. of mercury.

2 Strasburger discusses, in this connection, the existence of tangential pits in the autumnal wood (see *Leitungsbahnen*, p. 713).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MRS. RANDALL, of Massachusetts, has bequeathed to Radcliff College (the Harvard annex for women) 20,000 dollars; an equal amount to the Prospect Union, and 70,000 dollars to the Foxcroft Club of Harvard.

THE Council of University College, Liverpool, on the recommendation of the Senate and Medical Faculty, have converted the Medical Lectureship of Hygiene into a Professorship of Public Health, and have appointed Dr. E. W. Hope, Medical Officer of Health to the Corporation of Liverpool, to the chair.

THE London Polytechnic Council, a joint committee comprising representatives of the Council of the City and Guilds of London Institute, the Technical Education Board of the London County Council, and the central governing body of the City Parochial Foundation, adopted the following resolution at a specially convened meeting on Friday last:—"The London Polytechnic Council having had under their consideration the London University Commission Bill, and being satisfied that the students of London polytechnic institutes pursuing a course of study approved by the University under one or more of the recognised teachers of the University will enjoy equal facilities with students of a school of the University in graduating at the University, expresses its approval of the Bill and its hope that the Bill may be passed during the present Session, as affording a satisfactory solution of the London University question."

THE following are among recent appointments:—W. W. Watts, assistant geologist on the Geological Survey of the United Kingdom, to be assistant professor in Geology at the Mason College, Birmingham; Prof. R. C. Woodward to be president of the University of South Carolina; Dr. C. E. Beecher to be University professor of historical geology at Yale University; Dr. L. V. Pirsson to be professor of physical geology in the Lawrence Scientific School; Dr. F. E. Hull to be professor of physics in Colby University; Prof. William A. Rogers to be professor of physics in Alfred University at Alfred, N.Y.; Dr. Jaeger and Dr. Brodhun to be professors at the Reichsanstalt at Charlottenburg; Dr. Ignaz Zakezewski to be full professor of experimental physics at the University at Lemburg; Dr. H. Finger to be assistant professor of organic chemistry at the Polytechnic Institute in Darmstadt; Dr. A. L. Foley to be professor of physics in the University of Indiana; Dr. R. J. Aley to be professor of mathematics, and Mr. E. B. Copeland to be assistant professor of botany in the same University; Mr. T. I. Pocock to be assistant geologist on the Geological Survey of the United Kingdom; Dr. W. F. Hume and L. Gorringe to be assistants on the Geological Survey of Egypt.

THE London University Commission Bill passed through the House of Lords on Tuesday. The Duke of Devonshire, in moving the second reading on Friday last, said the Bill was substantially the same as the one which passed through the House with little discussion last Session, but for which, unfortunately, time did not allow full consideration in the other House. Certain modifications had been introduced which were the result of communications which had been in progress during almost the whole of the Session between those interested, and there was reason to hope that the difficulties which prevented the Bill from passing into law had been removed, and that it would pass now as practically an unopposed measure. He was sorry to say very considerable time had elapsed since Lord Cowper's Commission reported, and during that time a very great change had taken place in the higher education of the City of London, and this had caused the necessity for certain alterations of procedure in the Bill. Almost the only point discussed in the House last year was that which affected, or was supposed to affect, denominational colleges and principally King's College. The agreement which was arrived at last year had been embodied in somewhat different terms in the present Bill, and he believed it was now practically accepted by King's College and the principal bodies concerned, and was now not objected to by Lord Herschell, who took a strong line of opposition last year. The Earl of Kimberley said as he was a member of the Senate of the University he was aware of the circumstances to which the noble Duke had alluded, and which led to the introduction of this amended Bill. He did not think it was necessary or desirable to go into the provisions now; he would confine himself to saying the present form was the result of very careful consideration, he might say a compromise between the different interests. There was very sanguine hope, and he sincerely trusted it would be fulfilled, that the Bill in its present form was probably in the only form that would be acceptable to all parties concerned, and he hoped it might pass. The text of the Bill is printed in the *Times* of Saturday, July 24, from which we learn that the gentlemen who are to fill the statutory commission under the Bill are—Baron Davey, the Bishop of London, Lord Lister, Sir William Roberts, Sir Owen Roberts, Prof. Jebb, and Mr. E. H. Busk, the Chairman of Convocation of London University.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 5.—Polarisation capacities, by C. M. Gordon. These were determined by a new arrangement of Wheatstone's bridge, in which a known capacity and resistance are introduced into one branch, and an electrolytic cell of unknown capacity and resistance in the other. A minimum is obtained in the telephone when the capacities are inversely as the resistances in the remaining branches. The author found that for small currents the polarisation is a reversible process, and that the counter E.M.F. is rigidly given by Kohlrausch's equation $E = \frac{1}{c}\int idt$. The best results were obtained with electrodes of "platinised" platinum. —Effect of concussion and heat upon magnetism, by Carl Fromme. Concussion exerts a well-defined effect upon magnetisation, which is independent of that produced by deformation, and of the magnetic history of the material. It acts directly upon the molecular magnets, probably by producing groupings of them, which reduce the magnetic moment and lower the susceptibility. The effects of concussion may be imitated by sending an alternating current through the magnetising coil and gradually reducing it to zero. Also, in the case of iron wires, by making them vibrate transversely.—Röntgen rays, by A. Voller and B. Walter. As exhaustion is increased, less heat is developed in a discharge tube. The production of heat gives way before the production of Röntgen rays. The vacuum may be regulated by heating a small quantity of caustic potash in a side tube. The heating is best done by a small coil of wire carrying a current, wound on the outside of the side tube. The refractive index of diamond for X-rays does not differ from unity by more than 0·0002. This gives a limiting value for the wave-length of these rays. It is 1 $\mu\mu$, or the 600th part of that of the D line, assuming, of course, that the waves are transverse.—Co-efficient of thermal expansion of the white marble of Carrara, by I. Fröhlich. This is important, in view of its frequent use for inductance standards. Between 15° and 100° the mean coefficient of linear expansion is 0·000012.—Change of length of wooden rods with moisture and heat, by H. Stadthagen. Deal rods cut along the fibre were impregnated with linseed oil and painted with shellac varnish. The impregnation was carried out under a pressure of 1½ atmospheres and a temperature of 65°. It was found that the process does not make the rods independent of moisture, since the smaller pores remain accessible to it. The coefficient of expansion for 1 per cent. of relative humidity is 0·00001. The American method of compression at 200° under 14 atmospheres would probably yield better results.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 19.—M. A. Chatin in the chair.—The election of M. Virchow as Foreign Associate, in the place of the late M. Tchebichef, was approved by the President of the Republic.—Establishment of a uniform state in a pipe of large rectangular section, by M. J. Boussinesq.—Researches on the state in which elements other than carbon are found in cast iron or steel, by MM. Ad. Carnot and Goutal. The attack of the metal by appropriate solvents shows that silicon is present chiefly as the silicide FeSi. If manganese is present, however, the silicon combines with it in preference to iron. Sulphur behaves similarly, all the manganese apparently being turned into sulphide before any iron sulphide is formed. Phosphorus and arsenic show remarkable differences in their behaviour towards the solvent employed (a solution of potassium-copper chloride), the phosphorus being combined with the iron forming Fe_3P, while the arsenic is uncombined and simply dissolved in the casting.—Note relating to a memoir by M. D. Eginitis on the climate of Athens, by M. Lœwy.—Ephemeris of the periodic comet of D'Arrest, by M. G. Leveau.—On the quadratic integrals of dynamics, by M. P. Painlevé.—On the integration of systems of partial differential equations of the first order of several unknown functions, by M. Jules Beudon. —On surfaces referred to their lines of zero length, by M. Eugène Cosserat.—On a practical method of setting out gear teeth, by M. L. Lecornu.—On the phenomenon of the electric arc, by M. A. Blondel. In the experiments described, the passage of the current across the carbon poles was only broken

for 1/200th of a second, during which the back E.M F. of the poles was opposed to a single cell. The effect of the cooling of the carbons was thus eliminated, and the conclusion is drawn from the experiments, that the arc behaves exactly like an ordinary resistance, and presents no counter electromotive force comparable in magnitude to the difference of potential of the carbon poles.—On the action of electric charges upon the discharging power given to air by the X-rays, by M. Émile Villari.—On the properties of gases traversed by the X-rays, and on the properties of luminescent or photographic bodies, by M. G. Sagnac. A connection is traced between the rapidity of discharge of a conductor by the gases exposed to the X-rays, and the luminescence of the same gases.—The penetration of metals by the Röntgen rays, by M. Radiguet.—On the spectrum of carbon, by M. A de Gramont. A method is described for obtaining the spectrum of carbon free from foreign lines. Short intense sparks are passed through an alkaline carbonate, kept in a pasty state by a red-hot platinum spiral, the whole being placed in an atmosphere of dry carbonic acid or hydrogen. The spectrum obtained was identical with that given by Siberian graphite, with the exception of a doubtful ray in the red exhibited by the latter. Retort carbon, in spite of careful purification, gave numerous rays attributable to impurities such as calcium, barium, and iron.—Action of copper hydrate upon solutions of silver nitrate, by M. Paul Sabatier. The precipitation of cupric nitrate solutions by silver oxide appears to give rise to a basic nitrate of copper and silver.—Hydrobenzamide, amarine, and lophine, by M. Marcel Delépine. A thermochemical paper.—New syntheses with cyanosuccinic ether, by M. L. Barthe.—On some combinations of phenylhydrazine and metallic nitrates, by M. J. Moitessier.—On the aloïns, by M. E. Léger.—The function of auto-intoxication in mechanism of the death of animals deprived of their subrenal capsules, by M. D. Gourfein.—Nuclear purification at the commencement of ontogenesis, by M. L. Cuénot.—Variations of the lower fungi under the influence of the medium, by M. Julien Ray.—On the germination of grains of Leguminosæ containing parasitic larvæ, by M. Edmond Gain.

AMSTERDAM.

Royal Academy of Sciences, June 26.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Bakhuis Roozeboom, on melting-lines of systems of two and three organic substances.—Mr. Hamburger read a paper on a method of separation and quantitative determination of diffusible and non-diffusible alkali in serous fluids.—Prof. van Bemmelen made, on behalf of F. Schreinemakers, a communication concerning an inquiry into equilibriums in systems of three components in which two liquid phases occur.—Prof. Kamerlingh Onnes presented a paper, by Mr. E. van Everdingen, on the Hall effect and the increase of magnetic resistance in bismuth; and, on behalf of Mr. A. van Eldik, measurements of the capillary ascent of the liquid phase of a mixture of two substances in equilibrium with the gaseous phase.—Prof. Haga presented, on behalf of Dr. C. H. Wind, a contribution entitled "On the influence of the dimensions of the source of light in Fresnel's diffraction phenomena, and on the diffraction of X-rays" (second paper). In this paper the theory developed in the first paper was applied to the case of a narrow rectangular screen for obstacle. The shadow must consist principally of a nucleus, surrounded by maxima, or else—if the screen is very narrow—an illuminated space in the middle between minima, again followed by maxima. The distance of these maxima and minima from each other renders it possible to estimate the wave-length. Experiments with rays of light, as well as with X-rays, yielded diffraction images as expected; and from this it follows—at any rate, that in the case of X-rays—λ is very small.—Prof. Franchimont, on the action between methylnitramine and potassium nitrate in an aqueous solution at the ordinary temperature. The principal products are potassium nitrate, nitrogen and methylalcohol, besides dimethylnitramine and isodimethylnitramine. Secondary products are, among others, a little carbonic acid and a very volatile substance with a strong isonitril smell. The principal reaction is regarded by the author as an addition of methylnitramine to nitrous acid, followed by a decomposition of the product into nitric acid and diazomethyl hydrate; the latter then yields nitrogen and methylalcohol, and at the same time methylates a small portion of the methylnitramine. The author further states that all acid and all neutral aliphatic nitramines, and also nitro-urea, when treated with zinc in a solution of acetic acid, to which α naphhtylamine, dimethylaniline, aniline, metaphenylenediamine, &c., yield colouring matters, and that these reactions closely resemble those of nitrous acid, though an examination of the colouring matters themselves gives rise to doubt whether they are due to those reactions.—Prof. van der Waals presented: (*a*) On behalf of Prof. C. A. J. A. Oudemans, a paper in which the author publishes the finding of some fungi, hitherto unknown and injurious to agriculture, as *Brachyspora pisi* on the leaves of green peas (*Pisum sativum*), *Marsonia secalis* on the leaves of rye (*Secale cereale*), *Hendersonia grossulariæ* on the leaves of the gooseberry (*Ribes grossularia*), and *Fusicladium fagopyri* on the leaves of buckwheat (*Fagopyrum esculentum*). The author further points out that the names *Helminthosporium gramineum*, Eriksson, *Helm. teres*, Sacc., and *Helm. gramineum*, Rabh., are synonymous; and that the last-mentioned, being the oldest, ought to be retained; and finally describes a new genus of *Verpa*, growing in Java on refuse of *Indigofera tinctoria*, from which the colouring matter has been extracted, and which plant is eaten by the Javanese; the author calls this genus *Verpa indigocala*. (*b*) On behalf of Prof. Lorentz, a paper by Dr. C. H. Wind, on the dispersion of magnetic rotation of the plane of polarisation, with a note added by Prof. Lorentz. (*c*) On behalf of Dr. P. Zeeman, a paper on doublets and triplets in the spectrum produced by external magnetic forces (ii.).

BOOKS RECEIVED.

BOOKS.—A Course of Practical Chemistry: M. M. P. Muir. Part I. Elementary (Longmans).—Organic Chemical Manipulation: Dr. J. T. Hewitt (Whittaker).—Geographical Journal, Vol. ix. (Stanford).—A System of Medicine: edited by Dr. T. Clifford Allbutt, Vol. 3 (Macmillan).—The Potentiometer and its Adjuncts: W. C. Fisher (*Electrician* Company).—Cuirassés et Projectiles de Marine: E. Vallier (Paris, Gauthier-Villars). Les Huiles Minérales: F. Miron (Paris, Gauthier-Villars).—Physikalisches Praktikum: E. Wiedemann and H. Ebert, Dritte Verbesserte und Vermehrte Auflage (Braunschweig, Vieweg).—La Cure d'Altitude: Dr. P. Regnard Paris, Masson).

CONTENTS.

THURSDAY, AUGUST 5, 1897.

ORE DEPOSITS.

A Treatise on Ore Deposits. By J. Arthur Phillips, F.R.S. Second edition, rewritten and greatly enlarged by Henry Louis, M.A. Pp. xxii + 943. 128 illustrations, and index. (London: Macmillan and Co., 1896.)

PROFESSOR LOUIS has attempted no easy task in endeavouring to bring up to date Phillips' well-known work on ore deposits. Since the first edition appeared in 1884, mineral discoveries have been numerous and important. I need only refer to the gold of the Rand and Mount Morgan, the lead and silver of Broken Hill, the copper, silver and lead of Tasmania, the nickel of Sudbury, and the iron of Minnesota. Besides these comparatively new finds, one has to recollect the progress which has been made in developing some of the older mining districts. The years which have elapsed since 1884 have likewise been fruitful in bringing forth descriptions of ore deposits: scores of official memoirs, and hundreds of papers in the *Transactions* of scientific and technical societies at home and abroad, have been written about them; so that Prof. Louis must have had great difficulty in deciding what to ingraft upon the old stock without making his book too bulky. As it is, the second edition is half as big again as the first.

I cannot agree with Prof. Louis in excluding the minerals yielding aluminium and magnesium from the term "metalliferous ores," on the ground that by popular usage this term is applied solely to the ores of the heavy metals. We must march with the times. There was a day when hæmatite was not used for producing metallic iron; what we now call the ores of nickel and cobalt were long regarded as worthless and injurious substances. Zinc blende has only comparatively lately entered into the category of ores, and later still the carbonate of manganese. My opinion is that bauxite should rather be received with welcome into what Prof. Louis seems to consider as an aristocratic circle, than hustled out as an intruder because its metal happens to be light. After all, the ratio between the specific gravities of iron and aluminium does not differ very greatly from the ratio between the specific gravities of platinum and iron. The scientific man should rather try to lead the populace aright than cringe to misconceptions.

The book is divided into two parts: the first deals with mineral deposits generally, whilst the second is devoted to a description of the ore deposits of the various countries of the entire globe.

As several objections can be made to Phillips' classification of ore deposits, Prof. Louis very wisely abandons it; but, when he endeavours to find a substitute, he meets with many difficulties. Finally, he introduces a provisional arrangement in which origin, instead of form, is taken as the basis of the classification: giving new names to old faces, he subdivides all ore deposits into two kinds—"symphytic" and "epactic."

The former term is applied to deposits which are contemporaneous with the enclosing rocks, whilst the latter includes those which have been formed subsequently. Whether it is necessary to coin two more words with which to puzzle the unfortunate miner appears doubtful. The epactic deposits are next separated into two groups, and we eventually have three main classes, our old friends: (1) Beds; (2*a*) Veins; (2*b*) Masses.

The author of a large work dealing with all parts of the world can scarcely expect to escape some errors; nor is it easy to be quite up to date.

Prof. Louis has not corrected Phillips' erroneous description of the treatment of the lead-bearing sandstone at Mechernich, Rhenish Prussia. The book says that the little nodules of galena are separated below ground, and alone are sent to the surface, whilst the waste sand left behind is employed for filling the exhausted workings. As a matter of fact the nodules are extracted by a true dressing process above ground, more particularly by the aid of a special concentrator—the "Heberwäsche."

Phillips has likewise led Prof. Louis into error by saying that the Freiberg School of Mines was founded in 1702. The first project for the School was made at the end of 1765, and the lectures began at Easter 1766.

Following my usual custom, I cannot help tilting at the employment of unnecessary provincial terms in books upon mining. If "flucan" simply means "clay," why not stick to the word understood by all English-speaking persons, and consign to oblivion the Cornish term, which serves no useful purpose? On the other hand, if a provincialism is to be adopted on account of its brevity or general convenience, it should not be altered. I refer, as I have often done before, to the expression "country rock." By "country" the Cornishman means "surrounding rock"; to say "country rock" is tautology. Further, is it advisable to introduce into technical literature such a term as "lode formation," in the sense in which it is employed by ignorant persons or unthinking mining engineers? In the first place, the term "formation," as applied to lodes, already has a definite meaning attached to it. It denotes a group of mineral veins having certain characteristics, leading one to believe that they have a common origin. The so-called "lode formations" of Western Australia are veins of a special kind which can be described without bringing in the puzzling word "formation." The introduction of any new terms should be scrutinised by writers with the greatest jealousy, for the science of ore deposits is quite obscure enough already without being further darkened by a vague terminology.

Following Phillips, Prof. Louis retains the word "huel" in speaking of various Cornish mines, though the mining companies invariably write the word "wheal." Even if one admits that "huel" may be the more correct spelling, it is far too late now to think of enforcing it. It is not convenient for the student to have the name of a mine, "Wheal Mary Ann," for instance, inserted under the letter "h" instead of the letter "w," as he may be quite ignorant of the old way of writing the word.

Slight errors in the spelling of names of persons and places are a little too common. It may be hoped that the prefix "Sir" to Dr. Selwyn's name is simply the shadow of a coming event, and that it will cease to be a mistake long before the present edition is exhausted.

With regard to his own country, Prof. Louis is a little behind the times. He says that mining is "extensively"

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carried on in Anglesey and in the south-west of Ireland. Taking the official statistics for 1895, one finds that only thirteen persons were employed underground in Anglesey, and thirty-two in the county of Cork. These figures scarcely justify the adverb used by Prof. Louis. Herodsfoot mine is spoken of as if it were still at work, though it was abandoned fully ten years ago; in fact, Cornwall has ceased for some time to be a lead-producing county.

No doubt it is easier to pick a few holes in a work of this kind than to write it, and it must not be supposed from my criticisms that I in any way undervalue the great amount of care and labour which Prof. Louis has bestowed upon his work. The new book is a very valuable addition to technical literature, in spite of the want of a sufficient number of plates, which was likewise a fault of the first edition; possibly Prof. Louis may have had to bow to restrictions imposed upon him by his publishers. In any future edition it would be better to sacrifice some of the letterpress, if by so doing more figures could be introduced. C. L. N. F.

THE RESISTANCE OF THE AIR.

Experiments made with the Bashforth Chronograph to find the Resistance of the Air to the Motion of Projectiles. By Francis Bashforth, B.D. (Cambridge: at the University Press, 1895.)

IF Mr. Bashforth could have struck a bargain with the Government similar to that made by James Watt with the Cornish miners, his royalties on the gunpowder saved annually by the use of his Ballistic Tables would have rivalled the claims contested in some recent lawsuits.

By a few well-designed experiments with his Electro-Ballistic Chronograph, initiated now more than thirty years ago, when he took up the appointment of Professor of Mathematics to the Advanced Class of Artillery Officers, he was able to determine the resistance of the air at all useful velocities to the projectiles fired from the muzzle-loading guns then in vogue, to which a return had been made by our military authorities.

In accordance with the proverb—*Ὅτι οὐκ ἔστι προφήτης ἄτιμος, εἰ μὴ ἐν τῇ πατρίδι αὐτοῦ, καὶ ἐν τοῖς συγγενέσι καὶ ἐν τῇ οἰκίᾳ αὐτοῦ*—these experiments attracted great attention in naval and continental expert circles, everywhere except at Woolwich; they still remain to this day the only actual determinations of the Resistance of the Air with which we have to work in Artillery; and the Ballistic Tables of Mr. Bashforth, based upon these experiments, are to be found in all naval and foreign treatises on the Theory of Artillery.

When the Bashforth Chronograph revealed the unsteadiness of shooting of our guns, the manufacturers of ammunition and guns felt insulted, and wanted to throw the blame on the imperfections of the instrument, as if their manufactures were not absolutely perfect; now, however, in recent Range Tables, the manufacturers have to submit to the indignity of 50 per cent. zones, showing the degree of scattering of their weapon at the various ranges.

Although the breech-loading system has been finally adopted, and although the experimental side of Electricity may be said to have been re-created since Mr. Bashforth began to experiment, so far no new experiments have been carried out or sanctioned for finding the modification of the Resistance of the Air due to changes of shape in modern projectiles, and to the superior steadiness in flight obtainable with the breech-loading system.

Gunpowder, or cordite, costing annually many thousands of pounds, is blazed away at proof, merely to inspect brands of powder by determining a muzzle velocity, by shooting between two electric screens. If only one more screen, but the more the better, could be introduced, much useful information could be gained at the same time of the Resistance of the Air.

The Boulengé Chronograph, employed at proof, is not adapted for more than two screens; but superior Chronographs are now in the field, with which it is possible to read any number of screen records.

Every new Chronograph claims to record at least a millionth of a second; but Mr. Bashforth did not attempt to go behind the fourth decimal, knowing that the accuracy of any experiment is only that of its most inaccurate part; in this case the screens, in which the breaking of a wire might take place within the limits of a foot, according to the manner in which the wire is struck by the head or shoulder of the projectile; this alone is sufficient to account for a discrepancy enough to render the fourth decimal almost nugatory.

By averaging the results, however, of as many rounds as possible, Mr. Bashforth has arrived at the normal Resistance of the Air, from which individual shots may vary as much as 10 per cent. or more; and allowing for difference of shape, smoothness, and steadiness of projectile, the continental experiments of Krupp and others amply confirm Mr. Bashforth's results.

Inflation in the manufacture of warlike stores is at the present moment unprecedented; and yet very little careful examination takes place, of what improvements are possible as the result of scientific inquiry, carried out leisurely on a small scale. Our ministers vote millions for warlike stores, and still, as in the days of General Peel's report, they scrutinise with the greatest care a small vote, technically called ineffective, which serves to prevent these millions from being money thrown away.

Provided with Bashforth's Tables, and a knowledge of how to use them, which need not appreciably alter his weight or the height of his centre of gravity in the saddle, the artillery officer of the future might dispense with half the useless weight of ammunition he drags about in the field; or, at least, the same weight might be refashioned for a heavier gun, employing curved fire.

The superior ballistic coefficient of the larger projectile soon enables it to overtake the puny projectile of the rival pop-gun; but to secure these advantages, good range-finding is an indispensable accessory; the weight of the most efficient range-finder need not, however, exceed that of a single round, which might otherwise be expended as a trial shot.

Mr. Bashforth writes occasionally with bitterness; but he has been the victim of our curious official scientific etiquette, which disparages a new idea when submitted, and afterwards appropriates the results without acknowledgment when the idea has proved a success.

No doubt this etiquette is inspired from the highest quarters, but Mr. Bashforth was not the man to take such treatment lying down; he did not rest till he had extracted a written minute, acknowledging that his experiments had been adopted officially. But a bad mark has been put against him for his audacity; for while other inventors have been rewarded, we have yet to learn that Mr. Bashforth has received any acknowledgment from our own Government, either of a tangible or complimentary nature.

TEACHING THE TEACHERS.

Thirty Years of Teaching. By L. C. Miall, F.R.S., Professor of Biology in the Yorkshire College. Pp. viii + 250. (London: Macmillan and Co., Ltd., 1897.)

A FRIENDLY criticism of schoolmasters and their ways, written by a professor of biology, is a book of special value. Biology is a subject not usually taught in schools, and students taking it up at college are not in the condition which the schoolmaster is fond of describing as "thoroughly well-grounded in the elementary parts of the subject," and the scientific professor as "crammed with a multitude of imperfectly understood facts." The professor of biology therefore, in forming an opinion upon the previous training of his pupils, thinks more of the mental habits which they have formed than of the knowledge which they have acquired.

Prof. Miall is singularly fortunate in his suggestions upon the teaching of special subjects:—that geography should be taught mainly by means of map drawing; that text-books should be used merely as works of reference; that lessons in arithmetic and geometry should include practical work in measurement; that in teaching modern languages the written or spoken language should be made the basis, and instruction in grammar founded upon it; that mastery of English does not come by grammar and analysis, but by observation and practice; that true science consists in a scientific habit of mind, and not in a knowledge of scientific facts; that the present system of teaching classics to boys who leave school at sixteen, is laying a costly foundation for a structure which will never be built. These are truths which schoolmasters may or may not believe, but which very few of them follow in practice, influenced as they are chiefly by the demands of examinations, but also in part by the large numbers in their classes, and by the inertia of human nature. All that Prof. Miall says upon the method of teaching of every subject is well worthy the careful attention of every schoolmaster. Prof. Miall, too, shows a keen insight when he speaks of the true value of examinations, while the statement that the University local examinations were once a great step forward, but that they have now (like other human institutions) outlived their usefulness, and become rather a hindrance than a help, is one which may mark an epoch in the history of middle-class education.

In one point, however, we find the experience of the professor somewhat at variance with that of the schoolmaster. Prof. Miall appears entirely to overlook the moral elements of boyhood: he tells us, for instance, that boys will work at a subject in proportion to their interest in it; this is probably the case with students, but it is conspicuously not the case with schoolboys. The chief factor in causing the industry of a schoolboy is his sense of duty; the industrious boy is the one who has a strong sense of duty, the idle boy is he in whom the sense of duty has not been aroused; the main thing in which boys always will be interested is not their lesson, but each other. Again, Prof. Miall would abolish home-work for younger boys, and commence it with boys over fourteen; but, in this case, how much home-work would he get done? We venture to say that if boys had not formed the habit of doing a regular hour's evening work by the time they were twelve, they would never begin at all; the object of setting home-work to young boys is not to replace teaching, but to assist in forming regular and industrious habits. A few other instances might be given in which the experience gained by observing students would only lead to failure when applied to the teaching of schoolboys; and we doubt whether any boys could be taught by *class* lessons to read, write, and speak French by the age of fourteen.

Prof. Miall gives us some striking remarks upon the absurdity of extreme precision when based upon loose data, and some interesting biographies occupy the final chapters of his book; on the whole, we can thoroughly recommend "Thirty Years of Teaching" for the perusal of every schoolmaster and every parent in the country.

OUR BOOK SHELF.

Abhandlungen zur Physiologie der Gesichtsempfindungen. Edited by J. von Kries. Vol. i. Pp. vi + 198. (Hamburg and Leipzig: Leopold Voss, 1897.)

THE five papers in this volume are contributions from the Freiburg Physiological Institute, reprinted from the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane.* Dr. von Kries is the author of three papers dealing with the functions of the retinal elements, subjective effects produced by light of short duration, and colour vision, in the course of which a number of observations on the visual effects of different parts of the spectrum on different colour-blind individuals are recorded. Two other papers included in the collection are on the influence of light-intensity and adaptation on the vision of green-blind subjects, by Drs. J. v. Kries and W. Nagel; and on the influence of the yellow-spot—the part of the retina which lies directly in the axis of vision—upon colour appreciation, by Dr. Breuer.

Cuirassés et Projectiles de Marine. By E. Vallier. Pp. 188. (Paris: Gauthier-Villars et Fils; Masson et Cie, 1897.)

Les Huiles minérales; Pétrole, Schiste, Lignite. By François Miron. Pp. 198. (Same publishers.)

BOTH these volumes appear in the Encyclopédie scientifique des Aide-Mémoire series. M. Vallier's volume deals with the various kinds of armour-plates used upon men-of-war of different nations, and the projectiles employed for attacking these ironclads. In M. Miron's book, the extraction, composition, use, and analysis of mineral oils is described.

Botanische Wanderungen in Brasilien. By Prof. Dr. W. Detmer. Pp. vi + 188. (Leipzig: Veit and Co. 1897.)

IT is not given to many of us to realise our heart's desire, yet this is what Prof. Detmer did when he made a journey to Brazil. The impressions received from the start to the home-coming are set down in this little book, and the whole make an interesting narrative. The journey taken was through the States of Bahia, Rio de Janeiro, Minas Geraes, San Paulo, and Espirito Santo.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Röntgen Ray Theory.

THE most important question whether Röntgen rays are to be considered as falling into the domain of light, or whether they are something else, has occupied so many minds, that the literature on this subject has grown enormously; but is it settled yet whether they are transversal waves of very small wave-length, or longitudinal waves, or vortex motion of the ether, or longitudinal impulses, or due to electromagnetic dispersion, or radiant matter?

Having read so many theories, with so many supporters and opposers, one gets puzzled what to believe.

Not a small part of the confusion is caused by the number of contradictory experiments; and no wonder at this, the question being, in fact, of the utmost complication; that is to say, not only as to the nature of the rays themselves, but also the way in which to get them.

Being engaged in the study of silent electric discharges, it was rather in our line to consider the question of kathodic, as well as of our anodic, discharges. Thus we arrived at a conclusion about the nature of Röntgen rays, which explains a great deal, though we must confess that certain assumptions have to be made.

This is not an attempt to explain this most difficult problem, but to suggest an hypothesis that is most nearly in accordance with experiments, so far as they go.

We consider Röntgen rays to be nothing but discharged kathode rays, and will now test this hypothesis by seeing how it will explain some of the most striking experiments and facts.

As a matter of fact, kathode rays are deflected by a magnet; they obey the law of attraction of a current by a magnet; *i.e.* they behave as a current or stream of negatively charged particles.

These negative particles impinge upon the glass wall o. the tube, which, as is well known, possesses a strong positive (external) charge.

Is there anything strange in the idea that those particles may lose their charge when in contact with the positive charged wall, and proceed on their way as *discharged* particles?

These *discharged* particles cannot, and are not, attracted by a magnet; why should they be? Hence the essential difference between kathode and Röntgen rays is explained.

Röntgen rays would thus discharge a negatively or positively charged body, as a matter of course, since any electrified body, struck by neutral particles, always loses its charge.

Now let us consider some important details: in the first place, with regard to the focus tube. Some people do not accept the property of being reflected as possessed by the Röntgen rays. It seems to us that the experiments of Tesla with his T-tube, allowing him to take simultaneously a sciagraph from reflected and from rays that have passed through different plates of metal, are conclusive in this respect; but they prove that the total amount of reflexion varies not very much for the least and for the best reflectors; the maximum result obtained with zinc (platinum does not seem to have been tested) was only 3 per cent.

Probably platinum will give a higher percentage of reflected rays; but even then it does not sufficiently account for the large difference of efficiency of the ordinary and the focus tube.

According to our theory the real cause of the high efficiency of the focus tube lies in the fact that the kathode rays strike on an actual anode, instead of upon an anode by induction.

This, so far, is not new. To quote Lodge, in an article written some time ago: "Hence, undoubtedly the X-rays do not start from the kathode, or from anything attached to it, but do start from a surface upon which the kathode rays strike, whether it be an actual anode or only an anti-kathodic surface; best, however, if it be an actual anode."

Röntgen and Rowland had discovered the same thing. According to our theory, it is evident that the negatively charged particles can lose their charge sooner and more completely when they strike an actual anode, than when they strike an anode by induction (of greater surface, and thus of smaller density).

Everybody will agree with Prof. Peckham, where he says that the discharge-tube is a resonator for its coil, and when the coil and tube are properly attuned the maximum effect is obtained. We should say, when the discharging capacity of the surface struck by the kathode rays can keep time with the vibrations of the intermittent current or stream of charged particles, the most intense Röntgen rays will be obtained.

If discharging—or, better to say, neutralising—of the waves of negative particles from the kathode be not synchronous with their impinging upon the focus or wall, they cannot lose all their charge, and will proceed either as particles with a minute negative charge, or with a minute positive charge, or perhaps mixed with neutral parts.

The result will be feebler Röntgen rays, and, according to the preponderance of the one or the other particles, these rays will discharge an electrified body, and give it *charge* according to its own charge.

Borgmann found that a negatively charged plate, when exposed to Röntgen rays, lost its charge to become positively charged; when the plate was positively charged, it lost part of its charge.

Righi found just the contrary; a positively charged plate lost its charge to end with a negative charge.

Porter, and nearly all other experimenters, found in all cases a complete loss.

We could explain these differences by admitting that neither Borgmann nor Righi had pure Röntgen rays, but had them mixed with positive and negative rays respectively.

We consider Porter's X_1 X_2 X_3 rays, and Lenard's gamut of rays of more and less magnetic deflexibility, as Röntgen rays of less and more purity, *i.e.* neutrality.

The more perfectly the negative charge has been taken away by the anode—without, however, imparting a positive charge instead—the more intense the Röntgen rays will be, and the stronger penetrating power they will possess.

It is hardly necessary to say that it must be very difficult to obtain perfectly neutral rays; this end will obviously only be attained when the whole system of generating—current, frequency, self-induction, capacity, vacuum, size and form of tube, and all the rest—be in true harmony with one another; and to realise this, means no small thing to do in practice.

We do not venture to say that our theory explains everything, but we do think it explains much; we do not ignore the fact that it is difficult to understand how the Crookes' radiant matter could pass through the glass wall as discharged matter, but the theory of ether motion also presents difficulties. Experiments on the Lenard rays passing as charged particles through aluminium, are described in NATURE of May 27 (p. 93).

Why should the etheric disturbance in the air answer so closely to the vacuum in the tube? Why should the rays, if they be ether vibrations, which in any case must be of so short a wave-length that the well-known properties of light do not show, make any difference whether they are obliged to pass through one or the other metal or material? If the intermolecular space be of any influence to them, one should expect refraction in those materials that show greater resistance to the rays passing.

The strongest proof for our theory is Lafay's experiment, where he found that Röntgen rays, passed through a negatively charged leaf of silver, can again be deflected by a magnet, and in the same direction as the kathode rays in the tube: and when the leaf was positively charged, in the opposite direction.

That means that neutral, non-deflectible rays, after recharging, become again sensitive to the magnet; the deflection being absolutely in accordance with electromagnetic laws of attraction and repulsion.

Unfortunately this experiment, repeated by Lodge, has not been confirmed by him; but it is easy to understand that recharging, just like discharging, is no simple thing to accomplish.

A. VOSMAER.
F. L. ORTT.

Electrical Research Laboratory, The Hague, Holland.

Some Further Experiments on the X-Rays.

MESSRS. A. VOSMAER AND F. L. ORTT, in a paper kindly sent to me by the editor of NATURE, have arrived at the conclusion that the X-rays are more or less perfectly discharged particles. Others—Sir W. Crookes, for example—have suggested the

material nature of the rays, and the only novel point in the paper referred to seems to me to be that the rays owe their greater or less penetrative power to the fact that they are particles less or more free from electric charges. If this were the case, it seems scarcely possible that the particles could pass as freely through, and in the neighbourhood of, a conductor when charged as when uncharged. If the particles were completely without charge, it is true they should be equally affected by a conductor first charged positively, and then with an equal negative charge. On the other hand, if the particles were positively charged, they would experience stronger attraction to a conductor negatively electrified than to the same conductor equally positively charged; and the same, *mutatis mutandis*, may be said if they are negatively charged.

The effect one might expect is that the uncharged particles would at first be attracted by a charged conductor, and then repelled from it, if they acquired part of its charge, in which case the photographic image of the uncharged conductor produced by the X-rays would be modified in intensity if not in form [1]—probably in both.

If, as Messrs. Vosmaer and Ortt suppose, the "rays" are diselectrified by striking against the charged anode inside the tube, it is difficult to see why they should not be re-charged, and therefore act like other charged particles, if they strike against an electrified conductor *outside* the tube, especially if the potential of the external conductor be as great or greater than the potential of the internal. Indeed, the authors of the paper admit this; and if it is true, one might reasonably expect some such action as I have sought for.

I therefore thought it would be, at any rate, worth trying experiments to see if the X-ray photograph of a conductor, such as of a small plate of aluminium (with carefully rounded edges), differs according to (1) whether it be charged or not, and (2) whether it be charged positively or negatively.

According to the paper the X-ray particles are to be considered free from charge when they completely discharge a charged insulated plate, without afterwards imparting to it a charge, and the focus tube I used in all these experiments was one which gave rays of this description.

In the first set of experiments two small squares (A and B) with rounded edges, cut from the same piece of sheet aluminium, and one-thirtieth of an inch in thickness, were arranged in the same horizontal plane beneath the focus tube placed symmetrically with respect to the anode of the tube, so that the line joining the centres of the squares was in a direction at right angles to the line joining the centre of the anode and the centre of the kathode mirror. Below these small squares, and resting on a thick block of paraffin, was placed the photographic plate (all the plates used belonged to the same batch—the Ilford special rapid, and all the plates of each set of experiments were developed together in the same dish). The tube was worked by a large coil, giving six-inch sparks, and A and B were electrified when necessary by wires from the poles of a Wimshurst machine with leydens giving seven-inch sparks between the nobs when used in the ordinary way. The duration of each exposure was timed by a stop-watch in each case, and was as nearly as possible the same for each set of experiments.

A blank experiment in each set, in which the plate, wrapped in dark paper (the same number of folds in every case), was exposed to the radiation from A and B without the Röntgen rays, proved that no photographic effect was produced by their electrification by the Wimshurst.

Exposures were then made as follows:—

(1) A and B both earthed by a wire soldered to a gas-pipe.
(2) A positively, B negatively electrified.
(3) A negatively, B positively electrified.
(4) A positively, B to earth.
(5) A negatively, B to earth.
(6) A and B both earthed.

Development showed that the electrification of A and B was without effect, either absolute or comparative.

Since in the above experiments sparks passed between A and B when their difference of potential exceeded an amount far less than that which could be given by the Wimshurst, and it seemed possible that a stronger charge might still yield some indication of a difference, one of the aluminium squares was removed, and the other shifted till it was immediately beneath the anode, and a second set of experiments was made in a rather different way. In each pair of exposures the same plate was used, each half of the plate being protected, whilst the other half was exposed by a thick slab of plate glass—proved by experiment to allow no developable action of the X-rays to pass through it during the time of exposure used. The experiments were as follows:—

(1) A blank experiment without the X-rays in which one-half of the plate was exposed, first to A charged positively to the full power of the Wimshurst, and then the other half to A charged negatively in the same way. The result showed there was no developable action.

(2) 1st half X-rays only, then an interval of rest (the same interval being allowed between every experiment), then the 2nd half to the X-rays only; this was done to see how the emission of the tube varied.

(3) 1st half A positively charged, 2nd half X-rays only: A to earth.

(4) 1st A negatively. 2nd A to earth.
(5) 1st A positively. 2nd A negatively.
(6) 1st A insulated. 2nd A to earth.
(7) Same as (2).
(8) Same as (1).

The whole of this series was repeated, using the contents of one box of Edwards's isochromatic plates. Development showed no action which could be attributed to the electrification of A.

In a third series of experiments A was connected by a wire first to the kathode loop and then to the anode loop of the focus tube, and radiographs were taken comparing the effects of this treatment with that of earthing A; but these, too, gave no indication of any increase or decrease of the X-rays reaching the plate, nor of any re-distribution of the rays.

In a fourth set the photographic plate was placed on an ordinary discharging table, and brush discharges, and afterwards thick sparks were passed between the poles of the discharger, and the radiographs developed; but they showed no traces whatever of any effect of the sparks.

I, therefore, conclude that the radiograph of a conductor (though it is true I have only tried aluminium and brass) is not sensibly altered by even powerful electrification, nor are the rays altered in force or direction in passing through air in the neighbourhood of a powerfully-charged conductor, nor even through air which is being subjected to a powerful disruptive discharge.

This seems to me to make it more difficult to believe that the X-rays are due to particles, whether totally or partly devoid of charges of positive or negative electricity. T. C. PORTER.

Eton College, July 5.

[1] The alteration in form, and to a certain extent intensity, would depend partly on the velocity with which the particles were travelling. I do not remember reading of any determinations of the velocity of propagation of the X-rays; but if this remains very high over great distances, as it seems to do, it would appear very unlikely that the rays consist of material particles.

Primitive Methods of Drilling.

IN NATURE for June 10 (p. 140) there was an abstract of a monograph upon drills, dealing, among others, with those used in ancient Egypt. May I be permitted to point out that the object shown in Fig. 3 is not, as the author suggests, a drill bow, but a censer.

Again, the meaning of the sign *sam* (explained by Mr. McGuire as a disc drill), when used as a phonetic hieroglyph, is perfectly certain. It means "joining" or "union," and when accompanied by the lotus and papyrus (called "strings" by the author), "union of Upper and Lower Egypt." The figures accompanying it are most certainly gods, and not captives. At the same time, the sign *sam* occurs as a determinative to the word *casanet*, usually translated chisel, but which may well mean a drill such as Mr. McGuire indicates.

Constantinople, July 10. FRANZ CALICE.

Meteor of July 29.

IN case it may be of any interest to you, I beg to inform you that at 7.45 p.m., yesterday (Thursday, July 29), when standing 0° 29′ 40″ W., by 51° 10′ 12″ N. (Sparelands or Willinghurst on 1-inch Ordnance Map, Sheet 285, near Cranleigh) I saw a meteor fall in a direction bearing 46° east of north, as near as I could tell by a bearing subsequently taken. Its appearance was that of a falling magnesium star rocket. It did not appear to explode, but left a long trail of fragments.

Willinghurst, Guildford, July 30. J. V. RAMSDEN.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

III.

The Work proposed for the Indian Eclipse.

AMONG the work proposed to be carried on during the eclipse of 1896, it may be well imagined that the employment of the prismatic camera occupied a large place, but, unfortunately, the weather allowed no observation to be made by those of 6 inches and 9 inches aperture I took out to Kiö; the instrument employed in Brazil in 1893 was, however, again successful in the hands of Mr. Shackleton in Novaya Zemlya.

With regard to the work I propose to attempt in India, the following extracts from a letter I was called upon to write some time ago, still express my views. These are based upon the results obtained with the prismatic cameras in 1893 and 1896, which, although they are not yet fully worked out, in my opinion far transcend in importance any observations made on the eclipsed sun since 1868:—

"(1) I propose in 1898 to use a prismatic camera with double the present dispersion, although the dispersion employed by me in 1893 and 1896 was, I believe, far beyond anything obtained before.

"The facts are as follows. With the 6-inch prismatic camera used in 1893, the photographed spectrum was 3·1 inches long from D to K. With the 9-inch, which it was proposed to employ in 1896, the corresponding length of spectrum was 3·9 inches; while with the 3-inch prismatic camera actually used in Novaya Zemlya, the spectrum was 2·9 inches long from D to K.

"I believe the next highest dispersion obtained before was by Captain Hills in 1893, and by Dr. Schuster in 1886. Data are not available for exactly comparing the dimensions of the spectra then photographed with those stated above, but they were certainly considerably smaller in both cases.

"The imperative necessity for this increased dispersion may be gathered from the following facts concerning the spectrum of iron which I have best studied, and on which I have thousands of unpublished observations to compare with an eclipse spectrum when we can get one on a sufficient scale.

"Taking Rowland's lines, it may be generally stated that, on an average, one occurs at every 6/10 of a tenth-metre, the unit of measurement generally employed in such matters. With the dispersion in my photographs—the greatest so far obtained, as I have explained—we do not feel ourselves justified in assuming a greater accuracy than 5/10 of a unit. Evidently then, so far as this line of work alone is concerned, we can make no definite statements as to the presence or absence of iron lines in the eclipse photographs.

"So far as I am aware, no observations with the slit spectroscope will enable us to determine with any kind of exactness the relative composition of the successive layers of the sun's gaseous envelope. The difficulty chiefly arises, as I pointed out in 1882, from the fact that we have to deal with the projection of a sphere surrounded by vapours, and not with a section.

"On the other hand, the photographs taken with the prismatic cameras in 1893, and during the last eclipse, show clearly that there are essential differences in the composition of the envelopes at different levels, and the limits of various layers are indicated; but the dispersion is too small to enable us to define the chemical origins of the layers with sufficient certainty. A full statement of the evidence upon this point is included in the report on the results obtained with the prismatic cameras in 1893, which is now in the press.[2]

"(2) The prismatic camera has enabled us to photograph radiations at many different wave-lengths in the spectrum of the corona, differentiating them absolutely from the radiations of the chromosphere and prominences. This is a gigantic advance. But, in the prismatic camera photographs, the indications, except in the case of the 1474 ring, and two or three others, are very dim.

"It is important, therefore, to employ an integrating spectroscope of large dimensions to attempt to get stronger indications of these radiations *by utilising the greater area of the corona*, which of course the prismatic camera cannot do.

"(3) I may say, roughly, that in the (still unpublished) spectrum of the chromosphere obtained in 1893 and 1896, we deal with less than 10 per cent. of the Fraunhofer lines. It is of the first importance, then, to search for the others. I certainly saw some of them in 1882, but a very special inquiry is necessary. This I therefore include in my programme. These lines are certain to be dim, otherwise we should have photographed them already. The tendency of the observations of 1893 and 1896 is to show that they will be found in all probability above the chromospheric layer we have photographed, and associated with the coronal layers, of which we have photographed a few of the brightest radiations.

"The thicknesses of the chromospheric layers have been :—

		1893.	1896.
H and K	less than	5000 miles.	5000 miles.
G		3000 ,,	
4471	,,	3000 ,,	
Strontium line 4077		500 ,,	
Iron triplet ...	,,	500 ,,	
Shortest arcs of Fe, &c.	,,	500 ,,	90 miles.

"Beyond the dark moon, both in 1893 and 1896, we have indications of luminosity in the prismatic camera photographs, but no final statement can be made as to its origin.

"This gives us the spectrum of a part of the solar atmosphere at a great height :—

1893 ... 22,500 miles to 600,000 miles.
1896 ... 14,000 ,, to a height not yet determined.

"This, therefore, indicates a region, some 10,000 of miles in thickness, to be also explored, and the blank in the photographic evidence so far obtained suggests that eye observations must be employed.

"It will be seen from the above statement that the three parts of the proposed inquiry are all strictly connected, and that to employ any one of them without the others would greatly weaken the attack."

It will have been gathered that the chief object of the above observations is to determine the chemical and physical conditions of that part of the sun's atmosphere just above the photosphere, and therefore including the chromosphere.

Why so much importance is attached to such observations during eclipses, is that ordinary daily observations on the uneclipsed sun, although they carry us far, do not carry us far enough.

The results once obtained are not limited to the sun, they find their application in the study of every star in the heavens; it is, indeed, now recognised that observations of eclipses, such as those made in 1882, 1893, and 1896, provide us with a series of facts with which to approach the question of the absorption phenomena presented by the stars, and the whole question of the classification of stars depends almost absolutely upon their absorption phenomena.

In many of these bodies the atmosphere may be millions of miles high; in each star the chemical substances in the hottest and coolest portions may be vastly different; the region, therefore, in which the absorption takes place which, spectroscopically, enables us to discriminate star from star, must be accurately known before we can obtain the greatest amount of information from our inquiries.

I may say that for some time I was of opinion that in the sun many of the darkest lines indicated absorptions high up in the atmosphere, for the reason that the bright continuous spectrum of the lower levels might have an important effect upon line absorption phenomena by superposing radiation, and so diminishing the initial absorption. The observations of the eclipse of 1893, however, indicate that this opinion is probably only strictly true when the strata of the sun's atmosphere not too high above the photosphere are considered.

If we are justified in arguing from a star with a photosphere as well developed as that of the sun to one in which it is in all probability much less marked in con-

[1] Continued from page 178.
[2] This has since been published, and I shall refer to it later.

sequence of a much higher temperature, then we must consider that the absorptions which define the various star groups are more conditioned by the temperatures of the hottest regions merely than by the thickness of the absorbing atmospheres, or by the densities of the various vapours. Another consideration to be borne in mind is that if the atmospheres are in part composed of condensable vapours, and not entirely of gases permanent at all stellar temperatures, condensation must always be going on outside in the region of lowest temperature.

Hence it is important to consider the conditions of that part of the sun's atmosphere where it is known beyond all question that certain, but not all, of the absorptions which produce the Fraunhofer lines take place.

In my paper on the eclipse of 1893 (*Phil. Trans.*, 1896, vol. clxxxvii. A, p. 603), I referred at length to this point. The matter is so important that I do not hesitate to quote in the present connection what I then said:

"As a result of solar spectroscopic observations, combined with laboratory work, Dr. Frankland and myself came to the conclusion, in 1869, that at least in one particular, Kirchhoff's theory of the solar constitution required modification. In that year we wrote as follows (*Roy. Soc. Proc.*, vol. xvii. p. 88):—

"'May not these facts indicate that the absorption to which the reversal of the spectrum and the Fraunhofer lines are due takes place in the photosphere itself, or extremely near to it, instead of in an extensive outer absorbing atmosphere?'

"In an early observation of a prominence on April 17, 1870, I found hundreds of the Fraunhofer lines bright at the base, and remarked that a 'more convincing proof of the theory of the solar constitution put forward by Dr. Frankland and myself could scarcely have been furnished' (*Roy. Soc. Proc.*, vol. xviii. p. 358).

"During the eclipse of 1870, at the moment of disappearance of the sun, a similar reversal of lines was noticed; we had, to quote Prof. Young, 'a sudden reversal into brightness and colour of the countless dark lines of the spectrum at the commencement of totality.' On these observations was based the view that there was a region some 2" high above the photosphere, which reversed for us *all* the lines visible in the solar spectrum; and on this ground the name 'reversing layer' was given to it.

"Continued observations, however, led me, in 1873, to abandon the view that the absorption phenomena of the solar spectrum are produced by any such thin stratum, and convinced me that the absorption took place at various levels above the photosphere. I need not give the evidence here; it is set forth in my 'Chemistry of the Sun' (chap. xxii. pp. 303–309). On the latter hypothesis the different vapours exist normally at different distances above the photosphere, according to their powers of resisting the dissociating effects of heat (*Roy. Soc. Proc.*, vol. xxxiv. p. 292).

"My observations during the eclipse of 1882, in the seven minutes preceding totality, to my mind set the matter at rest. 'We begin with one short and brilliant line constantly seen in prominences, never seen in spots. Next another line appears, also constantly seen in prominences; and now, for the first time, a *longer* and thinner line appears, occasionally noted as widened in spots; while, last of all, we get, very long, very delicate relatively, two lines constantly seen widened in spots, and another line, not seen in the spark, and never yet recorded as widened in spots' (*ibid.*, vol. xxxiv. p. 297).

"Similar observations in the same part of the spectrum were made by Prof. Turner in 1886 (*Phil. Trans.*, 1889, vol. clxxx. A, p. 391). His observations were made under less favourable conditions than those in Egypt, and in the absence of statements as to the relative lengths of the lines observed, it is impossible to utilise them fully.

"This is one of the most important points in solar physics, but there is not yet a consensus of opinion upon it. Prof. Young and others, apparently, still hold to the view first announced by Dr. Frankland and myself in the infancy of the observations, that the Fraunhofer absorption takes place in a thin stratum, lying close to the photosphere."

I next proceeded to discuss the numerous photographs obtained during the eclipse, and I gave a map showing that there was only the slightest relation between the intensities of the lines common to the Fraunhofer and the eclipse spectrum, and, further, that only a few of the Fraunhofer lines are represented at all. Not only this, but in the eclipse photographs there are many bright lines not represented at all among the Fraunhofer lines.

The chromosphere, then, is certainly not the origin of the Fraunhofer lines, either as regards intensity or number. From the eye observations made since 1868, I pointed out many years ago that there is evidence that the quiescent chromosphere spectrum indicates a higher temperature than that at which much of the most valid absorption takes place; in other words, that the majority of the lines associated with lower temperature are produced above the level of the chromosphere; while the eclipse photographs of 1893 and 1896 afford evidence

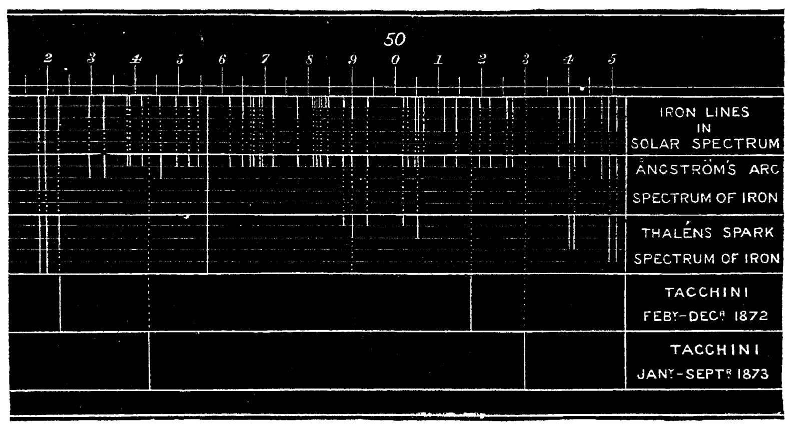

FIG. 10.—Tacchini's observations of the iron lines at 4924·1 and 5018·6 on the spectrum of the quiet chromosphere in 1872. It will be observed that new prominence lines were recorded when the iron lines disappeared.

by the greater length of some of the lower temperature lines that we need not locate the region which produces them at any great height above the chromosphere.

The solar evidence, then, is that most of the line absorption is produced in, and not very far above, the chromosphere. This is a conclusion we are bound to accept in a discussion of the origin of stellar absorption in the absence of evidence to the contrary. We have no right to assume that the absorption will be produced at the top of the atmosphere in one star, and in the bottom in another, when the atmospheres are once relatively quiescent.

Quite recent work has very greatly strengthened these conclusions in regard to the sun. The conclusion with regard to the high temperature of the quiescent chromosphere depended chiefly upon the Italian observations and upon investigations communicated by myself to the Royal Society in 1879 (*Roy. Soc. Proc.*, 1879, vol. xxx. p. 22), and 1881 (*ibid.*, 1881, vol. xxxii. p. 204), on the effect of high-tension electricity on the line spectra of metals (FIG. 10).

These investigations consisted in noting (1) the lines brightened in passing a spark in a flame charged with metallic vapours, and (2) the lines brightened on passing from the arc to the spark. It was found, in the case of

iron, that two lines in the visible spectrum at 4924·1 and 5018·6, on Rowland's scale, were greatly enhanced in brightness with higher temperatures, and were very important in solar phenomena. Thus the line at 4924·1 was at times the only representative of iron in the chromosphere; upwards of 1000 lines in the visible spectrum of iron gave no sign.

Spots are conceded to be cooler phenomena than those observed in other parts of the photosphere, so we should not expect to find the hotter lines so frequent in them. Fig. 11 gives the facts. It is a comparison of the iron lines observed in spots, and in the quiet chromosphere during the same time in 1872, the spots being observed at Kensington, the chromosphere at Palermo. It will be seen that none of the lines seen in the chromosphere were seen in the spots, and *vice versâ*.

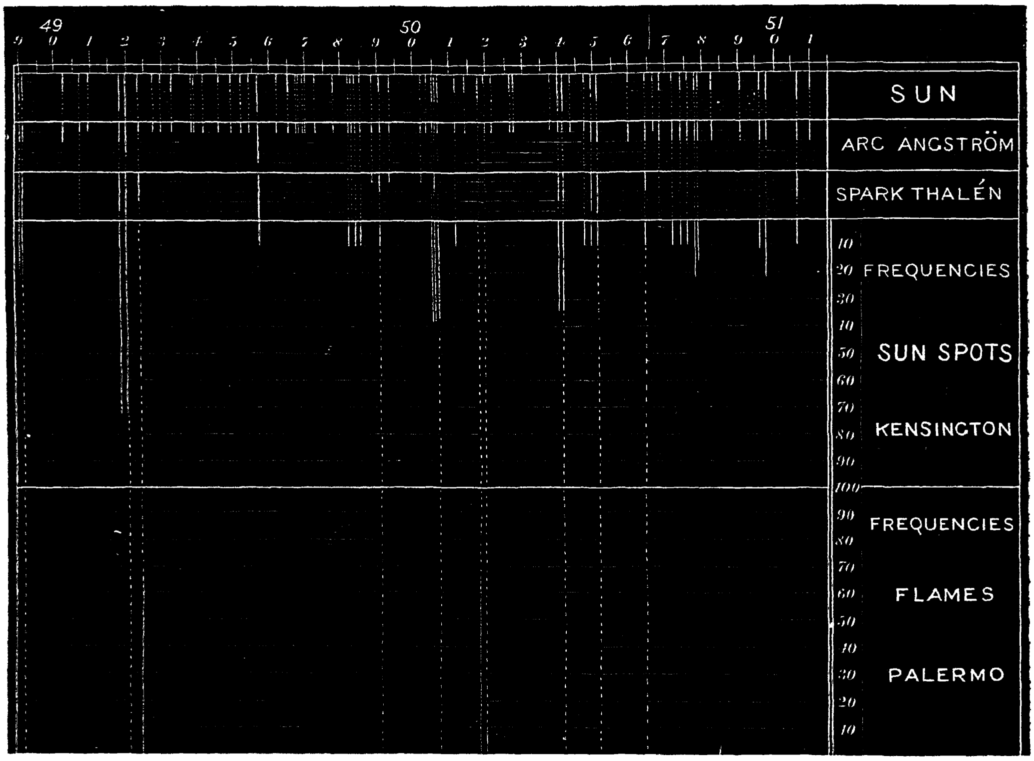

FIG. 11.—Iron spot-lines seen at Kensington confronted with iron prominence lines seen at Palermo.

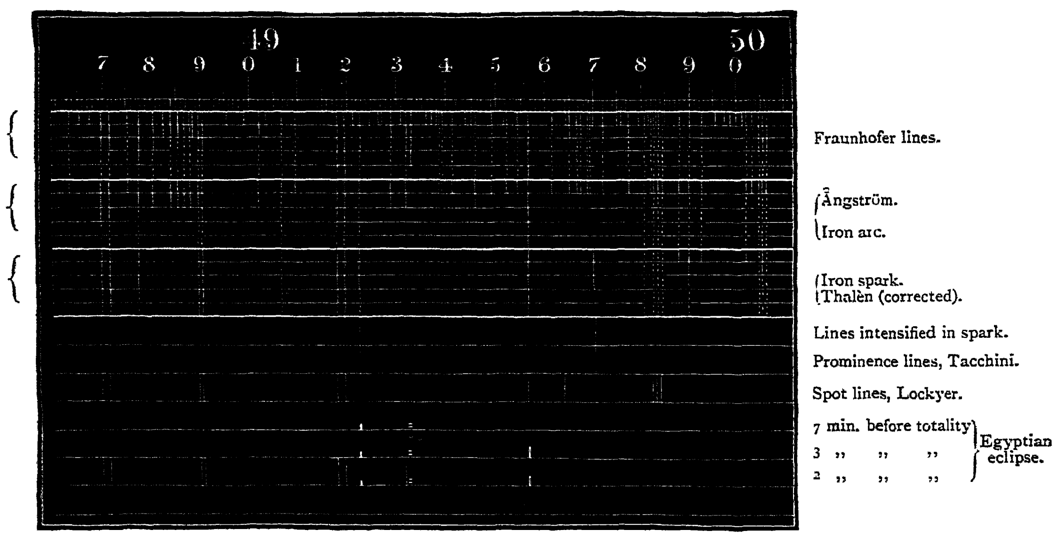

FIG. 12.—The line seen during the Solar Eclipse in 1882, showing that the prominence line at 4924·1 was seen short and bright seven minutes before totality, and some of the spot lines were not seen till two minutes before totality, and then they were observed long and dim.

It was natural to suppose that the iron vapour producing the cooler lines was higher up than that responsible for the enhanced line at 4924·1. Hence a crucial observation was planned for the eclipse of 1882. If the vapour were higher it should be dimmer, and its lines should, if seen at all, be seen long and faint very near the beginning of totality, while the hotter line, being produced by vapours relatively low and at a higher temperature, should be seen short and bright some time before the beginning of totality.

Fig. 12 will show how absolutely the prediction was verified by the event.

J. NORMAN LOCKYER.

(*To be continued.*)

ON LUNAR AND SOLAR PERIODICITIES OF EARTHQUAKES.

THE investigation of small periodical changes is rendered difficult chiefly by the doubt which so often exists, whether the results obtained by the ordinary methods are due to accident or prove some real periodically acting cause. Attention need only be drawn to the many calculations which have been made to trace the sunspot period in terrestrial phenomena, such as rainfall or temperature, to show that widely different conclusions may be drawn from the same evidence according as greater or smaller value is attached to the element of chance. I have been engaged for some time to apply the theory of probability to investigations of this nature, with a view if possible to being able in every instance to assign a definite number to the probability that any periodicity which may be found in the record of some physical phenomenon is of an accidental nature. In a paper recently communicated to the Royal Society, I have applied the results obtained to the periodicities of earthquakes. Mr. Knott (*Proc. Roy. Soc.*, vol. lx. p. 457) has recently published some investigations, conducted with skill and labour, which in his judgment were favourable to the existence of a true lunar influence on earthquakes. The theory of probability, however, does not support that view. The number of earthquakes treated by Mr. Knott is 7427, and Fourier's series is applied to determine the amplitudes of the changes which have periods coincident with the lunar day, the half-day and the third or fourth part of a lunar day. The method employed would always give some results whether a true periodicity existed or not, and I have calculated what the average amplitudes would be if earthquakes were distributed quite at random. These amplitudes depend, of course, on the number of events taken into the calculation, and are found to vary inversely as the square root of that number. The following table will show how the amplitudes found by Mr. Knott compare with those calculated by the theory of probability. C_1 in the table refers to the lunar day, while C_2, C_3 and C_4 refer to its submultiples.

Coefficients	C_1	C_2	C_3	C_4
Expectancy for the coefficients	19·3	15·7	10·6	5·2
By the theory of probability...	10·3	17·9	10·9	3·97

As it may further be shown that cases will frequently occur where the amplitudes found are equal to twice the expectancy, the table may be considered as conclusive that if a lunar effect exists, it must be so small that it is quite hidden by accidental effects. For the present, at any rate, the evidence is against such a lunar influence. A discussion of the periods, coincident with the lunar months, leads to the same conclusion.

It is otherwise with the annual and daily periods, which have recently been discussed by Mr. Davison. Here the amplitudes found are decidedly too large to be due to accident; and we may therefore say, with a degree of probability amounting practically to certainty, that there is a yearly period giving a maximum of earthquakes in December, and a daily period giving a maximum some time between ten o'clock in the morning and noon.

ARTHUR SCHUSTER.

NOTES.

A SMALL committee has been appointed by the Treasury "to consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards of measurement, and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes, and to report whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost." The following will be the members of the committee:—The Lord Rayleigh, F.R.S. (chairman), Sir Courtenay Boyle, K.C.B., Sir Andrew Noble, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Prof. W. C. Roberts-Austen, C.B., F.R.S., Mr. Robert Chalmers, of the Treasury, Prof. A. W. Rücker, F.R.S., Mr. Alexander Siemens, Dr. T. E. Thorpe, F.R.S.

AT a meeting of the Royal College of Physicians of London, on Thursday last, the College, on the recommendation of the Council, awarded the Moxon gold medal to Sir Samuel Wilks, F.R.S., the President of the College, for having especially distinguished himself by observation and research in clinical medicine, and the Baly medal to Prof. Schäfer, F.R.S., for having especially distinguished himself in the science of physiology. The Harveian oration will be delivered by Sir William Roberts on October 18, St. Luke's Day. Dr. E. Markham Skerritt, of Bristol, will give the Bradshaw lecture on November 4; and Dr. F. Pavy will deliver a special lecture, supplementary to the Croonian lectures, delivered in 1894, on November 11. The following were announced as lecturers for next year:—Goulstonian lectures, Dr. John Rose Bradford; Lumleian lectures, Sir Richard Douglas-Powell; Croonian lectures, Dr. Sidney Martin.

A PARLIAMENTARY paper has just been issued giving an additional Civil Service Estimate, amounting to 10,000*l.*, for Art and Science buildings of Great Britain. The total original net estimate for 1897–98 was 26,000*l.*, and this has been increased to 36,000*l.* The British Museum and the Science and Art Department buildings receive 5000*l.* each for new works, alterations, and additions. The increased grant to the Science and Art Department is on account of the cost of carrying out certain urgent works and services at South Kensington, designed to give effect to the recommendations made in the first report from the Select Committee on the Museums of the Department. It is proposed to remove the more dangerous buildings on the east side of Exhibition Road (including the "boilers" and the electric lighting plant), to displace the occupants of the official residences, and reconstruct the entrance to the galleries on the west side of Exhibition Road.

THE Weights and Measures Bill (Metric System), the scope of which has already been described (p. 275), was read a third time and passed in the House of Lords on Friday last.

WE notice with regret that the Hon. Ralph Abercromby, who did so much for the advancement of meteorological science, died at Sydney, New South Wales, on June 21, at fifty-four years of age.

IT is announced in *Die Natur* that Prof. Rudolf Leuckart, the Nestor of German zoologists, has been made a knight of the Order pour le mérite in science and art by the German Emperor. The same distinction has been conferred upon Prof. Karl Neumann, professor of mathematics at Leipzig.

MR. S. P. LANGLEY, Secretary of the Smithsonian Institution, was present at the meeting of the Paris Academy of Sciences on Monday. In the course of a few remarks upon his experiments in mechanical flight, which he made at the invitation of the President, Mr. Langley said he had greatly enlarged the distance which his aeroplanes would run, without much altering his apparatus. He will shortly publish a detailed account of all he has done upon the subject.

WHAT is believed to be the largest Land Tortoise now living in the world has been lately deposited in the Zoological Society's Gardens by Mr. Walter Rothschild. It is about 4 feet 7 inches in total length, and 2 feet 10 inches in breadth, and weighs about 5 cwt. As regards weight, however, the animal is in poor condition and will probably "put on flesh" when carefully fed. This tortoise belongs to the species called *Testudo daudini* by Duméril and Bibron, which is figured on the fifth plate in Dr. Günther's well-known memoir on Gigantic Land Tortoises. It was originally brought from the Aldabra Islands in the Indian Ocean, though it is said to have been kept elsewhere in captivity for the last 150 years.

THE King of Siam, who arrived in this country on Friday last, paid a visit to the Kew Gardens on Sunday morning, his son, Lord Harris, and several members of the Royal suite accompanying him. The party was received by Mr. Thiselton-Dyer, and afterwards spent some time in the inspection of the various houses and conservatories. His Majesty throughout displayed the keenest interest in the ferns, orchids, and rich variety of Oriental and tropical plants. Many of these he recognised and admired, and noted from time to time that rare specimens of other places were in his own country grown in the open air. He compared the vast and varied collection of Kew with the famous gardens at Buitenzorg, in Java, with which he is familiar, and told Mr. Thiselton-Dyer that his visit was only a preliminary one, and that he should look forward to another occasion when he might inspect the treasures of Kew at greater leisure. After expressing his thanks to the director the King left the gardens. The King and his son and some members of the suite also paid a visit to Greenwich Observatory on Sunday.

THE annual meeting of the Iron and Steel Institute was opened at Cardiff on Tuesday.

AT a recent meeting of the Council of the Australasian Association for the Advancement of Science, letters were read which had been received from the Royal Society of Tasmania, the Royal Geographical Society (Melbourne branch), and the Medical Society of Queensland, suggesting certain means for permanently recording the services to science of the late Baron von Müller, and, in view of the importance of the subject, it was resolved to defer its consideration till the next meeting. The acceptance of the secretaryship of the Section of Economic Science and Agriculture, by Mr. R. R. Garran, was communicated; also that of Mr. H. C. Kent, of the Section of Engineering and Architecture; and that of Dr. F. Tidswell, of the Section of Sanitary Science and Hygiene. Drs. J. W. Springthorpe (Melbourne), D. Hardie (Queensland), and J. Ashburton Thompson forwarded their acceptances of the office of vice-president of this last Section. On the motion of Mr. G. H. Knibbs, it was resolved that Profs. Liversidge, Threlfall, Haswell, Mr. H. C. Russell, and Mr. Deane be deputed to form a preliminary committee to consider the question of appointing a reception committee to arrange for evening lectures, conversazione, a concert, excursions for scientific and other purposes, visits to works, garden parties, conferences, &c., and for the entertainment of members during the week of session. A list of papers promised was laid on the table, and the Secretary reported that the promises of scientific contributions to the various Sections were coming in most satisfactorily.

FOR some little time past there has been a local agitation in favour of opening Kew Gardens to the public in the mornings of week-days. Two deputations waited upon Mr. Akers-Douglas, First Commissioner of Works and Buildings, on Friday last, to urge the desirability of the earlier opening of the gardens. Mr. Akers-Douglas, however, while promising to give the views of the deputations careful consideration, held out no hope of their request being complied with. He said the *raison d'être* of the existence of Kew Gardens was the valuable scientific work it did, and he could not be expected to do anything in the way of extending the hours during which the gardens were open to the general public if it would interfere with that work. The financial question did not weigh with him at all, for if he were convinced that the interests of science would not suffer by the earlier opening he should endeavour to persuade the Treasury to grant any extra money required. The sole question for consideration was whether the interests of science could be combined with the desire of the people for the earlier opening, and he regretted to say that the scientific men whose opinions he had obtained were entirely opposed to the proposal. From a scientific point of view the experiment had not been a success in Edinburgh, and they had no reason to anticipate any better result at Kew.

THE current number of the *Annales de l'Institut Pasteur* contains two very important communications on the etiology of yellow fever, the one by Dr. Sanarelli of Montevideo, and the other by Dr. Havelburg of Rio de Janeiro. Some months ago Dr. Sanarelli gave a lecture in which he reviewed his researches on this subject, a description of which appeared in our issue of July 15; his present communication is a detailed account, occupying eighty pages and elaborately illustrated, of his investigations, and he purposes to continue their recital in a second memoir at a later stage of his inquiries. Dr. Havelburg has worked quite independently of Sanarelli, and has also succeeded in isolating a micro-organism which he holds responsible for yellow fever. He, moreover, places this microbe in the group of coli and typhoid bacilli, and regards it as a form intermediate between these microbes and those associated with hæmorrhagic septicæmia, to which it also bears some resemblance. Cultures of both Sanarelli's and Havelburg's yellow fever microbes have been forwarded by their respective discoverers to the Pasteur Institute in Paris, and are being there submitted to a careful examination to establish their identity or difference. Havelburg mentions that he was able to immunise a dog against yellow fever infection so that its serum protected guinea-pigs from this disease. He hopes to extend his researches in this direction.

PROF. T. R. FRASER, F.R.S., whose experiments on immunisation against serpents' venom, and the treatment of snake-bite with antivenene, have been fully described in these columns (vol. liii. p. 569, 1896), has made another contribution to this subject. His experiments showed, among other things, that, when introduced into the stomach of an animal, serpents' venom produces no obvious injury, even when the quantity is so large as to be sufficient to kill 1000 animals of the same species and weight if the venom were injected under the skin. An investigation of this remarkable fact has now proved that the cause is to be found in the bile, which has such a decided influence upon serpents' venom that it is sufficient in itself to

account for the innocuousness of stomach administration. It is shown that the bile of venomous serpents is able, when mixed with the venom of serpents, to prevent lethal doses of the latter from producing death; and that the bile is indeed so powerful an agent in doing this, that a quantity actually smaller than the quantity of venom may be sufficient for the purpose. It need scarcely be added that the doses of bile thus shown to be sufficient represent only minute portions of the bile stored in the gall-bladder of a serpent, and that a serpent, therefore, has at its disposal enough of bile to prevent injury from venom introduced into the stomach in quantities many times greater than the minimum lethal dose. The bile of other animals, such as the ox, rabbit, and guinea-pig, also possesses this anti-venomous property, but in a smaller degree than that of venomous serpents. Prof. Fraser has isolated the antidotal constituent from the bile of venomous serpents, and an experiment with this substance not only supplies strong confirmation of the evidence that bile is able to render serpents' venom inert, but also suggests that from bile there may be produced an antidote for snake-poisoning, which, in its antidotal value, is at least equal to the most powerful antivenene or antivenomous serum as yet obtained from the blood of immunised animals.

THE Porthcawl Urban District Council required a water supply; and to the majority of the members it appeared that a water diviner was the most competent man to inform them how to obtain their desire. A specialist, for whom water had strong attractions, was thereupon engaged, though more than one half of the ratepayers opposed this action, thus showing that they were more enlightened than their elect. However, a total expenditure of about 800*l.* was made in connection with the water supply, and apparently upon the recommendations of the water diviner. Nothing might have been known of this scheme outside Porthcawl but for the inquiry which the Local Government Board holds in the case of such expenditure. As the result of the inquiry, however, the water finder's fees have been disallowed on the ground that they had been illegally paid to a person supposed to be possessed of supernatural powers, and upon whose advice several hundred pounds had been spent, which action involved waste of public money. The whole of the expenditure was therefore disallowed, less 250*l.* allowed as a loan for experimental purposes. The Council has thus to pay dearly for its experience.

THE *Annales* of the Central Meteorological Office of France for 1895 contain a valuable discussion of the rainfall of Western Europe, by M. A. Angot. Next to temperature, rainfall is the most important meteorological element, but owing to the difficulty that the subject presents, it has only been seriously attacked in a few cases, the principal exceptions in Europe being for the British Islands, Russia, and the Iberian Peninsula. The influence of topographical conditions and the varying amount of rainfall make it necessary to deal with a great many stations, and a considerable number of years. It is also essential that the data should be for the same years, otherwise the rainfall of a relatively dry period at one station may be compared with a relatively wet one at another station. M. Angot has discussed the monthly and seasonal values at 275 stations for the thirty years 1861–1890. At many of the stations a longer series was available, but at some it has been necessary to reduce a shorter period to the longer one by use of coefficients. The values are given both in a tabular form and upon charts, and a short discussion for each month explains the principal features of the rainfall. Space will not allow us to enter into any of the interesting details shown by the monthly and seasonal charts. The yearly chart shows that the dryest regions, where the rainfall is less than 20 inches, are few in number and small in extent. Outside the Iberian Peninsula there are only five such regions: the south-east coast of Sweden, two in Bohemia, and two in France. In Spain there are several large areas where the fall does not reach that amount, the minimum value being 11·3 inches at Salamanca. Smaller values are recorded in Russia, but this is outside the area of the charts. The greatest amounts are found in Scotland, Cumberland, the southern slopes of the Alps, and the mountainous region of Upper Austria, where the falls exceed 78 inches.

A CORRESPONDENT sends us an extract from a Melbourne paper, *The Age*, for March 13, on the subject of weather forecasting in Australia, which, in the light of Mr. Eliot's recent article in these columns, is of great interest. The following is a brief summary of the communication in question:—Since Christmas the extraordinary weather that has been experienced in Australia has created more than usual interest in meteorological affairs. There have been three falls of snow in the Victorian Alps within the last three months, and at the time of writing (March) Mounts Bogong and Feathertop were covered with snow to a depth of six feet. Mr. Baracchi stated recently that the bad weather of the last few days was caused by the "backing of the Antarctic depression, which has been arrested in its eastward course by suction at the equator." He may be correct, for he has "carefully, as we have seen, kept the data on which his opinion is founded to himself, but it seems somewhat unusual and unlikely." Mr. Russell, of New South Wales, attributes the cold weather to an extensive high pressure of great energy which has come in almost a direct line from West Australia. The writer of the article previously suggested that a probable cause of the unreasonable weather was the unwonted number of icebergs and ice-fields in the Southern Ocean, for almost every ship that hailed from the Cape passed through hundreds of miles of ice.

IN some years the pack-ice and icebergs from Victoria Land drift in vast quantities more northwards than in others, and the cause of their abundance this year is, according to the U.S. Hydrographic Department, the great volcanic disturbances which have broken up the polar sea and set it adrift. Mr. Russell's explanation is that we owe their presence to the long continuance of southerly and south-westerly winds; but this explanation does not account for the *cause* of such winds. It is, however, "only reasonable to conclude that there is an intimate association between the cold weather and the icebergs." Usually the air blows over a large expanse of open ocean, which warms it before it approaches the coast of Australia; but in the present year they were chilled by blowing over vast fields of ice and icebergs. It would be interesting, however, to examine carefully the meteorological observations made on ships during their voyages, and it is suggested that "our meteorologists would act wisely were they to imitate the example of the American authorities, who offer inducements to shipmasters for such information."

MR. THOS. MEEHAN records ("Contributions to the Life-Histories of Plants," xii., *Proc. Acad. N.S. Philadelphia*) a case of cleistogamy in an umbelliferous plant, *Cryptænia canadensis.* This species, like so many others of the same order, produces two kinds of flowers in the same inflorescence. The outer florets are male, and possess showy corollas, whilst the inner flowers are hermaphrodite, possessing both stamens and pistil concealed in a small fugacious corolla. Fertilisation takes place in the unopened buds, and thus the process may be legitimately regarded as one of cleistogamy, although the degeneration of floral structure, usually a concomitant feature, is relatively little apparent. There can exist but little doubt that the (assumed) function of the outer sterile showy florets as serving to attract insect visitors proved to be imperfectly dis-

charged, and that a ruinous situation has only been saved by a recourse to self-fertilisation, which is undergoing evolution along cleistogamic lines.

THE U.S. Department of Agriculture, Division of Botany, Washington, has just issued as one of the series of "Contributions from the U.S. National Herbarium," "Notes on the Plants used by the Klamath Indians of Oregon," by F. V. Coville. The author, while engaged in a botanical survey of the plains of south-eastern Oregon in the summer of 1896, spent three days at Fort Klamath and the Klamath Indian Agency, from whence he was enabled to secure information as to the principal plants used by the Klamath Indians. The notes are now issued with a view to their use by others in securing fuller and more varied data about the aboriginal uses of plants by this tribe. The author hopes, when the necessary material has been collected, to prepare a comprehensive paper on the subject. The present list includes a few plants which give suggestions of usefulness in the arts and industries of others besides the Indians, among which may be mentioned the yellow pine-lichen, which produces a beautiful canary-yellow dye; the Rocky mountain flax, which furnishes a strong, fine fibre; and several of the tuberous-rooted perennials of the parsley family, which make palatable and nutritious foods.

WE have upon our table the following new editions:—"Elemente der Geologie," by Dr. Hermann Credner (Leipzig: Wilhelm Engelmann.) This is an eighth revised edition of a work which first appeared twenty-five years ago. It is a bulky volume of eight hundred pages, illustrated by more than six hundred woodcuts. As a handbook of general geology the work has found considerable favour in Germany.—"Physikalisches Praktikum," by Eilhard Wiedemann and Hermann Ebert. Third revised and enlarged edition (Brunswick: F. Vieweg and Son.) In this work the principles of physics are described with special reference to physico-chemical methods. The volume should be in the hands of every student of physical chemistry familiar with the German language. It is a book both for physical and chemical laboratories, and it contains a course of practical work which should be completed by every student before he begins the study of chemistry.—Messrs. Macmillan and Co. have published the first volume of the sixth edition, revised and enlarged, of "The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies," by Dr. E. J. Routh, F.R.S. The dynamical principles of the subject are given in this first volume, together with the more elementary applications, the more difficult theories and problems being reserved for the second volume. Many additions and improvements have been made in the work.—Messrs. Hodder and Stoughton have published a cheap edition (twenty-fifth thousand) of the late Dr. Drummond's "Lowell Lectures on the Ascent of Man."

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. Fleming; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. G. H. Cheverton; a Wood Brocket (*Cariacus nemorivagus*, ♀) from Buenos Ayres, presented by Mr. C. Passingham; a Purplish Death Adder (*Pseudechis porphyriacus*), a Brown Death Adder (*Diemenia textilis*), a Shielded Death Adder (*Notechis scutatus*) from Australia, presented by Mr. E. H. Bostock; two Grooved Tortoises (*Testudo calcarata*) from South Africa, deposited; a Green-billed Toucan (*Ramphastos discolorus*) from Guiana, purchased; three Bar-tailed Pheasants (*Phasianus reevesi*), three Amherst Pheasants (*Thaumalea amherstiæ*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PERIODIC COMET D'ARREST.—M. Gustave Leveau publishes in the *Astronomischen Nachrichten* (No. 3434) a more accurate ephemeris for D'Arrest's comet than has yet appeared. It may be mentioned that the comet has not only been observed by Mr. Perrine at the Lick Observatory, but also at the observatories of Algiers and Toulouse. By employing these observations the following ephemeris has been computed.

Ephemeris for Paris Mean Midnight.

1897		α h. m. s.		δ ° ′
Aug. 5	...	3 35 13	...	+5 43·8
,, 7	...	39 10	...	34·4
,, 9	...	43 0	...	24·3
,, 11	...	46 43	...	13·5
,, 13	...	50 18	...	2·0
,, 15	...	53 46	...	4 49·9
,, 17	...	3 57 5	...	4 37·1

NATAL OBSERVATORY REPORT.—Mr. Nevill, the Government Astronomer, in his report to the Colonial Secretary for the year 1896, points out that although he has been able with his small staff to cope with the ordinary routine work of the observatory, there is still a great amount of useful and important work which has accumulated, and which awaits printing and publishing. Among these is a valuable contribution to the theory of the moon, which consists of the reduction of all the observations of the moon to a uniform basis and their comparison with the portion of Hansen's tables, whose theoretical accuracy is undoubted. From the difference between these two results must be determined the approximate value and probable period and character of all the terms of long period and their associated terms of shorter period, which are indicated by the observations and shown by the comparison to be required to be added to the known portion of the complete theory in order to enable it to properly represent the motion of the moon. A second piece of work, which is far advanced, consists of a simple and powerful method of calculating from theory the values of such terms as those mentioned above, and to apply them to the computation of the exact values of all the terms shown to exist by the comparison between theory and observation. It may be mentioned that both these investigations have been in progress for some years, and now that they are so near completion their publication should not be delayed. The report contains a detailed account of all the meteorological observations made at the observatory for the past year, in addition to tables of "mean values" for the past eleven years.

CHRONOMETERS.—Those who are specially interested in the performance of chronometers will find Prof. Raoul Gautier's report on the "Concours International de réglage pour chronomètres de poche de haute précision," which was presented last year, a very interesting pamphlet. The object of this competition was to examine in every respect the performance of chronometers sent by standard makers, and to award prizes to those which behaved best under the given conditions. The marks were divided into four groups: 100 points for mean daily error, this must not *exceed* ± 0·75s.; 100 for mean error of position, which must not exceed ± 2·5s.; 100 for error of compensation, which must be under ± 0·20s.; and 50 for "reprise de marche," which was not allowed to exceed 5·00s. Of the 142 chronometers examined 12 exceeded 256·7 points, while 32 obtained over 233·3. The most highly rewarded "series of three chronometers" obtained in the mean 271·5 points, one of these, No. 298,225, having received 284·7 points. For further details regarding the actual errors measured, we must refer the reader to the original pamphlet, where he will find all the required information minutely discussed and tabulated.

NEW DETERMINATION OF PRECESSIONAL MOTION.—The *Astronomical Journal* (vol. xvii. No. 21) contains a new determination of the constant of precession which was undertaken by Prof. Simon Newcomb at the request of a conference held in Paris in 1896. This conference was brought together to discuss a report on what was to be considered the best system of fundamental stars to be adopted for international use. Prof. Simon Newcomb was chosen to represent this part of the inquiry, and his work having now been accomplished, he pub-

lishes, previous to his official communication, a brief abstract of the results at which he has arrived. The discussion, he tells us, was beset with difficulties, the most troublesome being the parallactic motion of the stars arising from the solar motion. Another difficulty was the fact that the proper motions of the stars did not follow the normal or exponential law of error on which the method of least squares and the practice of taking them are based. Prof. Newcomb divided the work into four parts, employing what he calls the statistical method, the method of individual stars, the method of zones and regions, and a method of which the parallactic motion is eliminated. The results may be briefly summed up in the following table.

	Struve-Peters.	New.	Diff.
	"	"	"
General precession	5025·24	5024·53	– 0·71
Luni-solar ,,	5038·23	5036·84	– 1·39
Value of 100 m.	4607·65	4607·11	– 0·54
,, 100 n.	2005·64	2005·11	– 0·53

DIAMONDS.[1]

IT seems but the other day I saw London in a blaze of illumination to celebrate Her Majesty's happy accession to the throne. As in a few days the whole empire will be celebrating the Diamond Jubilee of our Queen, who will then have reigned over her multitudinous subjects for sixty years, what more suitable topic can I bring before you than that of diamonds! One often hears the question asked: "Why *Diamond* Jubilee?" I suppose it is a symbol intended to give a faint notion of the pure brilliancy and durability of the Queen's reign; and in thus associating Her Majesty with the precious diamond, to convey an idea of those noble qualities, public and private, which have earned for her the love, fealty, and reverence of her subjects.

From the earliest times the diamond has occupied men's minds. It has been a perennial puzzle—one of the riddles of creation. The philosopher Steffans is accredited with the dictum that, "Diamond is quartz which has arrived at self-consciousness!" and an eminent geologist has parodied this metaphysical definition, saying, "Quartz is diamond which has become insane!"

Prof. Maskelyne, in a lecture "On Diamonds," thirty-seven years ago, in this very theatre, said: "The diamond is a substance which transcends all others in certain properties to which it is indebted for its usefulness in the arts and its beauty as an ornament. Thus, on the one hand, it is the hardest substance found in nature or fashioned by art. Its reflecting power and refractive energy, on the other hand, exceed those of all other colourless bodies, while it yields to none in the perfection of its pellucidity"; but he was constrained to add, "The formation of the diamond is an unsolved problem."

Recently the subject has attracted many men of science. The development of electricity, with the introduction of the electric furnace, has facilitated research, and I think I am justified in saying that if the diamond problem is not actually solved, it is certainly no longer insoluble.

GRAPHITE.

Intermediate between soft carbon and diamond come the graphites. The name graphite is given to a variety of carbon, generally crystalline, which in an oxidising mixture of chlorate of potassium and nitric acid forms graphitic acid easy to recognise. Graphites are of varying densities, from 2·0 to 3·0, and generally of crystalline aspect. Graphite and diamond pass insensibly into one another. Hard graphite and soft diamond are near the same specific gravity. The difference appears to be one of pressure at the time of formation.

Some forms of graphite exhibit a remarkable property, by which it is possible to ascertain approximately the temperature at which graphites were formed, or to which they have subsequently been exposed. Graphites are divided into "sprouting" and "non-sprouting." When obtained by simple elevation of temperature in the arc or the electric furnace they do not sprout; but when they are formed by dissolving carbon in a metal at a high temperature, and then allowing the graphite to separate out on cooling, the sprouting variety is formed. One of the best varieties is that which can be separated from platinum in ebullition in a carbon crucible. The phenomenon of sprouting is easily shown. Place a few grains in a test-tube and heat it to about 170° C., when it increases enormously in bulk and fills the tube with a light form of amorphous carbon.

The resistance of graphite to oxidising agents is greater the higher the temperature to which it has previously been exposed, Graphites, which are easily attacked by a mixture of fuming nitric acid and potassium chlorate, are rendered more resistant by strong heat in the electric furnace.

I will now briefly survey the chief chemical and physical characteristics of the diamond, showing you by the way a few experiments that bear upon the subject.

COMBUSTION OF THE DIAMOND.

When heated in air or oxygen to a temperature varying from 760° to 875° C., according to its hardness, the diamond burns with production of carbonic acid. It leaves an extremely light ash, sometimes retaining the shape of the crystal, consisting of iron, lime, magnesia, silica, and titanium. In boart and carbonado the amount of ash sometimes rises to 4 per cent., but in clear crystallised diamonds it is seldom higher than 0·05 per cent. By far the largest constituent of the ash is iron.

The following table shows the temperatures of combustion in oxygen of different kinds of carbon:—

	°C.
Condensed vapour of carbon	650
Carbon from sugar, heated in an electrical furnace	660
Artificial graphites, generally	660
Graphite from ordinary cast-iron	670
Carbon from blue ground, of an ochrey colour	690
,, ,, ,, very hard and black	710
Diamond, soft Brazilian	760
,, hard Kimberley	780
Boart from Brazil	790
,, from Kimberley	790
,, very hard, impossible to cut	900

At the risk of repeating an experiment shown so well at this table by Prof. Dewar, I will heat a diamond to a high temperature in the oxyhydrogen blowpipe and then suddenly throw it in a vessel of liquid oxygen. Notice the brilliant light of its combustion. I want you more especially to observe the white opaque deposit forming in the liquid oxygen. This deposit is solid carbonic acid produced by the combustion of the carbon. I will lead it through baryta water, and you will see a white precipitate of barium carbonate. With a little more care than is possible in a lecture I could perform this experiment quantitatively, leading the carbonic acid and oxygen, as they assume the gaseous state, through baryta water, weighing the carbonate so formed, and showing that one gramme of diamond would yield 3·666 grammes of carbonic acid—the theoretical proportion for pure carbon.

Some crystals of diamonds have their surfaces beautifully marked with equilateral triangles, interlaced and of varying sizes. Under the microscope these markings appear as shallow depressions sharply cut out of the surrounding surface, and these depressions were supposed by Gustav Rose to indicate the probability that the diamonds at some previous time had been exposed to incipient combustion. Rose also noted that striations appeared on the surfaces of diamonds burnt before the blowpipe. This experiment I have repeated on a clear smooth diamond, and have satisfied myself that during combustion in the field of a microscope, before the blowpipe, the surface becomes etched with markings very different in character from those naturally inscribed on crystals. The artificial striæ are cubical and closer massed, looking as if the diamond during combustion had been dissected into rectangular flakes, while the markings natural to crystals appear as if produced by the crystallising force as they were being built up.

I exhibit on a diagram a form of graphite from the Kimberley blue ground (reproduced from M. Moissan's work), which in its flaky crystalline appearance strangely resembles the surface of a diamond whose internal structure has been partially dissected and bared by combustion. It looks as if this piece of graphite was ready to separate out of its solvent as diamond, but owing to some insufficient factor it retained its graphitic form.

[1] A lecture delivered at the Royal Institution, June 11, by William Crookes, F.R.S.

PHYSICS OF THE DIAMOND.

The specific gravity of the diamond is from 3·514 to 3·518. For comparison, I give in tabular form the specific gravities of the different varieties of carbon:—

Amorphous carbon	1·45 to 1·70
Graphite	2·11 ,, 3·0
Hard gas coke	2·356
Boart	3·47 ,, 3·49
Carbonado	3·50
Diamond	3·514 ,, 3·518

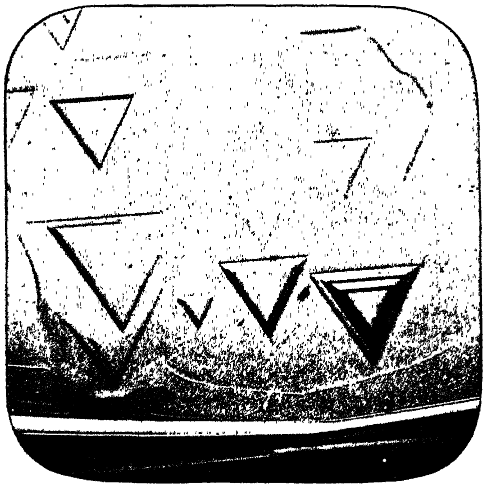

FIG. 1.—Triangular markings on natural face of a diamond.

The following table gives the specific gravities of the minerals found on the sorting tables. I have also included the specific gravities of two useful liquids:—

	Specific gravity.
Hard graphite	2·5
Quartzite and granite	2·6
Beryl	2·7
Mica	2·8
Hornblende	3·0
METHYLENE IODIDE	3·3
DIAMOND...	3·5
THALLIUM LEAD ACETATE	3·6
Garnet	3·7
Corundum	3·9
Zircon	4·4
Barytes	4·5
Chrome and titanic iron ore	4·7
Magnetite...	5·0

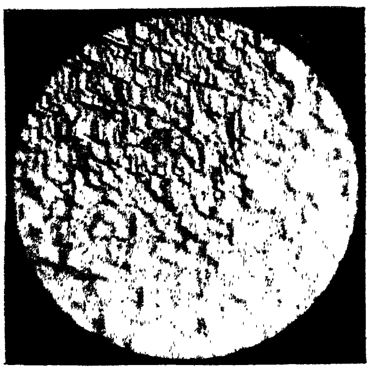

FIG. 2.—Artificial markings on face of a diamond, produced by partial combustion.

This table shows that if I throw the whole mixture of minerals into methylene iodide, the hornblende and all above that mineral will rise to the surface; while the diamond and all minerals below will sink to the bottom. If I now take these heavy minerals, and throw them into thallium lead acetate, they will all sink, except the diamond, which floats and can be skimmed off.

The diamond belongs to the isometric system of crystallography. It frequently occurs with curved faces and edges. Twin crystals (macles) are not uncommon. Having no double refraction it should not act on polarised light. But, as is well known, if a transparent body which does not so act is submitted to strain of an irregular character it becomes doubly refracting, and in the polariscope reveals the existence of the strain by brilliant colours arranged in a more or less defined pattern, according to the state of tension in which the crystal exists. Under polarised light I have examined many hundred diamond

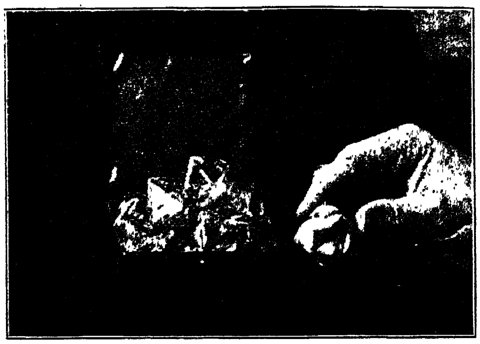

FIG. 3.—Natural crystals of diamond.

crystals, and with few exceptions all show the presence of internal tension. On rotating the polariser, the black cross, which is most frequently seen, revolves round a particular point in the inside of the crystal, and on examining this point with a high power, we see sometimes a slight flaw, more rarely a minute cavity. The cavity is filled with gas at an enormous pressure, and the strain is set up in the stone by the effort of the gas to escape.

It is not uncommon for a diamond to explode soon after it reaches the surface, and some have been known to burst in the pockets of the miners or when held in the warm hand. Large crystals are more liable to burst than smaller pieces. Valuable stones have been destroyed in this way, and it is whispered that cunning dealers are not averse to allowing responsible clients to handle or carry in their warm pockets large crystals fresh from the mine. By way of safeguard against explosion, some dealers embed large diamonds in raw potato to ensure safe transit to England.

In the substance of many diamonds we find enclosed black uncrystallised particles of graphite. There also occur what may be considered intermediate forms between the well-crystallised diamond and graphite. These are "boart" and "carbonado." Boart is an imperfectly crystallised diamond, having no clear portions; therefore it is useless for gems. Boart

FIG. 4.—Natural crystals of diamond.

is frequently found in spherical globules, and may be of all colours. It is so hard that it is used in rock-drilling, and when crushed it is employed for cutting and polishing other stones. Carbonado is the Brazilian term for a still less perfectly crystallised form of carbon. It is equally hard, and occurs in

porous masses, and in massive black pebbles, sometimes weighing a couple or more ounces.

Diamonds vary considerably in hardness, and even different parts of the same crystal are decidedly different in their resistance to cutting and grinding. The famous Koh-i-noor, when cut into its present form, showed a notable variation in hardness. In cutting one of the facets near a yellow flaw, the crystal became harder and harder the further it was cut into, until, after working the mill for six hours at the usual speed of 2400 revolutions a minute, little impression was made. The speed was accordingly increased to more than 3000, when the work slowly proceeded. Other portions of the stone were found to be comparatively soft, and became harder as the outside was cut away.

Beautifully white diamonds have been found at Inverel, New South Wales, and from the rich yield of the mine and the white colour of the stones, great things were expected. A parcel of many hundred carats came to England, when it was found they were so hard as to be practically unworkable as gems, and I believe they were ultimately sold for rock-boring purposes.

I will illustrate the intense hardness of the diamond by an experiment. I place a diamond on the flattened apex of a conical block of steel, and on the diamond I bring down a second cone of steel. With the electric lantern I will project an image of the diamond and steel faces on the screen, and force them together by hydraulic power. Unless I happen to have selected a diamond with a flaw, I shall squeeze the stone right into the steel blocks without injuring it in the slightest degree.

But it is not the hardness of the diamond so much as its optical qualities that make it so highly prized. It is one of the most refracting substances in nature, and it also has the highest reflecting properties. In the cutting of diamonds advantage is taken of these qualities. When cut as a brilliant the facets on the lower side are inclined so that light falls on them at an angle of 24° 13′, at which angle all the incident light is totally reflected. A well-cut diamond should appear opaque by transmitted light, except at a small spot in the middle where the table and culet are opposite. All the light falling on the front of the stone is reflected from the facets, and the light passing into the diamond is reflected from the interior surfaces and refracted into colours when it passes out into the air, giving rise to the lightnings and coruscations for which the diamond is supreme above all other gems.

The following table gives the refractive indices of diamonds and other bodies:—

REFRACTIVE INDICES FOR THE D LINE.

Chromate of lead	2·50–2·97
Diamond	2·47–2·75
Phosphorus	2·22
Sulphur	2·12
Ruby	1·78
Thallium glass	1·75
Iceland spar	1·65
Topaz	1·61
Beryl	1·60
Emerald	1·59
Flint glass	1·58
Quartz	1·55
Canada balsam	1·53
Crown glass	1·53
Fluor-spar	1·44
Ice	1·31

According to Dr. Gladstone, the specific refractive energy, $\frac{\mu - 1}{d}$, will be for the D line 0·404, and the refraction equivalent, $P\frac{\mu - 1}{d}$, will be 4·82.

After exposure for some time to the sun many diamonds glow in a dark room. Some diamonds are fluorescent, appearing milky in sunlight. In a vacuum, exposed to a high-tension current of electricity, diamonds phosphoresce of different colours, most South African diamonds shining with a bluish light. Diamonds from other localities emit bright blue, apricot, pale blue, red, yellowish green, orange, and pale green light. The most phosphorescent diamonds are those which are fluorescent in the sun. One beautiful green diamond in my collection, when phosphorescing in a good vacuum, gives almost as much light as a candle, and you can easily read by its rays. The light is pale green, tending to white.

CONVERSION OF DIAMOND INTO GRAPHITE.

I will now draw your attention to a strange property of the diamond, which at first sight might seem to argue against the great permanence and unalterability of this stone. It has been ascertained that the cause of phosphorescence is in some way connected with the hammering of the gaseous molecules, violently driven from the negative pole, on to the surface of the body under examination; and so great is the energy of the bombardment, that impinging on a piece of platinum, or even iridium, the metal will actually melt. When the diamond is thus bombarded in a radiant matter tube the result is startling. It not only phosphoresces, but assumes a brown colour, and when the action is long continued becomes almost black.

I will project a diamond on the screen and bombard it with radiant matter before your eyes. Some diamonds visibly darken in a few minutes, while others, more leisurely in their ways, require an hour.

This blackening is only superficial, but no ordinary means of cleaning will remove the discolouration. Ordinary oxidising reagents have little or no effect in restoring the colour. The black stain on the diamond is due to a form of graphite which is very resistant to oxidation. It is not necessary to expose the diamond in a vacuum to electrical excitement in order to produce a change.

I have already signified that there are various degrees of refractoriness to chemical reagents among the different forms of graphite. Some dissolve in strong nitric acid; other forms of graphite require a mixture of highly concentrated nitric acid and potassium chlorate to attack them, and even with this intensely powerful agent some graphites resist longer than others. M. Moissan has shown that the power of resistance to nitric acid and potassium chlorate is in proportion to the temperature at which the graphite was formed, and with tolerable certainty we can estimate this temperature by the resistance of the specimen of graphite to this reagent.

The superficial dark coating on a diamond after exposure to molecular bombardment I have proved to be graphite (*Chemical News*, vol. lxxiv., p. 39, July 1896), and M. Moissan (*Comptes rendus*, cxxiv. p. 653) has shown that this graphite, on account of its great resistance to oxidising reagents, cannot have been formed at a lower temperature than 3600° C.

It is therefore manifest that the bombarding molecules, carrying with them an electric charge, and striking the diamond with enormous velocity, raise the superficial layer to the temperature of the electric arc, and turn it into graphite, whilst the mass of diamond and its conductivity to heat are sufficient to keep down the general temperature to such a point that the tube appears scarcely more than warm to the touch.

A similar action occurs with silver, the superficial layers of which can be raised to a red heat without the whole mass becoming more than warm (*Proc. Roy. Soc.*, vol. l. p. 99, June 1891).

This conversion of diamond into graphite is, I believe, a pure effect of heat. In 1880 (*Proceedings of the Royal Institution*) Friday Evening Meeting, January 16, 1880) Prof. Dewar, in this theatre, placed a crystal of diamond in a carbon tube, through which a current of hydrogen was maintained. The tube was heated from the outside by an electric arc, and in a few minutes the diamond was converted into graphite. I will now show you that a clear crystal of diamond, heated in the electric arc (temperature 3600° C.) is converted into graphite, and this graphite is most refractory.

The diamond is remarkable in another respect. It is extremely transparent to the Röntgen rays, whereas highly refracting glass, used in imitation diamonds, is almost perfectly opaque to the rays. I exposed over a photographic plate to the X-rays for a few seconds the large Delhi diamond, of a fine pink colour, weighing 31½ carats, a black diamond weighing 23 carats, together with an imitation in glass of the pink diamond lent me by Mr. Streeter; also a flat triangular crystal of diamond of pure water, and a piece of glass of the same shape and size. On development, the impression where the diamond obscured the rays was found to be strong, showing that most rays passed through, while the glass was practically opaque. By this means imitation diamonds and some other false gems can readily be

detected and distinguished from the true gems. It would take a good observer to distinguish my pure triangular diamond from the adjacent glass imitation.

GENESIS OF THE DIAMOND.

Speculations as to the probable origin of the diamond have been greatly forwarded by patient research, and particularly by improved means of obtaining high temperatures. Thanks to the success of Prof. Moissan, whose name will always be associated with the artificial production of diamonds, we are able to-day to manufacture diamonds in our laboratories—minutely microscopic, it is true—all the same veritable diamonds, with crystalline form and appearance, colour, hardness, and action on light the same as the natural gem.

Until recent years carbon was considered absolutely non-volatile and infusible; but the enormous temperatures at the disposal of experimentalists—by the introduction of electricity—show that, instead of breaking rules, carbon obeys the same laws that govern other bodies. It volatilises at the ordinary pressure at a temperature of about 3600° C., and passes from the solid to the gaseous state without liquefying. It has been found that other bodies which volatilise without liquefying at the ordinary pressure will easily liquefy if pressure is added to temperature. Thus, arsenic liquefies under the action of heat if the pressure is increased; it naturally follows that if along with the requisite temperature sufficient pressure is applied, liquefaction of carbon will be likely to take place, when on cooling it will crystallise. But carbon at high temperatures is a most energetic chemical agent, and if it can get hold of oxygen from the atmosphere or any compound containing it, it will oxidise and fly off in the form of carbonic acid. Heat and pressure, therefore, are of no avail unless the carbon can be kept inert.

It has long been known that iron when melted dissolves carbon, and on cooling liberates it in the form of graphite. Moissan discovered that several other metals have similar properties, especially silver; but iron is the best solvent for carbon. The quantity of carbon entering into solution increases with the temperature, and on cooling in ordinary circumstances it is largely deposited as crystalline graphite.

Prof. Dewar has made a calculation as to the critical pressure of carbon—that is, the lowest pressure at which carbon can be got to assume the liquid state at its critical temperature, that is the highest temperature at which liquefaction is possible. He starts from the vaporising or boiling point of carbon, which, from the experiments of Violle and others on the electric arc, is about 3600° C., or 3874° Absolute. The critical point of a substance on the average is 1·5 times its absolute boiling point. Therefore the critical point of carbon is 5811° Ab., or, say, 5800° Ab. But the absolute critical temperature divided by the critical pressure is for elements never less than 2·5. Then—

$$\frac{5800^\circ \text{ A.}}{\text{PCr}} = 2{\cdot}5, \text{ or PCr} = \frac{5800^\circ \text{ A.}}{2{\cdot}5}, \text{ or 2320 atmospheres.}$$

The result is that the critical pressure of carbon is about 2300 atmospheres, or, say, 15 tons on the square inch. The highest critical pressure recorded is that of water, amounting to 195 atmospheres, and the lowest that of hydrogen, about 20 atmospheres. In other words, the critical pressure of water is ten times that of hydrogen, and the critical pressure of carbon is ten times that of water.

Now, 15 tons on the square inch is not a difficult pressure to obtain in a closed vessel. In their researches on the gases from fired gunpowder and cordite, Sir Frederick Abel and Sir Andrew Noble obtained in closed steel cylinders, pressures as great as 95 tons to the square inch, and temperatures as high as 4000° C. Here, then, if the observations are correct, we have sufficient temperature and enough pressure to liquefy carbon; and if the temperature could only be allowed to act for a sufficient time on the carbon, there is little doubt that the artificial formation of diamonds would soon pass from the microscopic stage to a scale more likely to satisfy the requirements of science, industry, and personal decoration.

ARTIFICIAL MANUFACTURE OF THE DIAMOND.

I will now proceed to manufacture a diamond before your eyes—don't think I yet have a talisman that will make me rich beyond the dreams of avarice! Hitherto the results have been very microscopic, and are chiefly of scientific interest in showing us nature's workshop, and how we may ultimately hope to vie with her in the manufacture of diamonds. Unfortunately, the operations of separating the diamond from the iron and other bodies with which it is associated are somewhat prolonged—nearly a fortnight being required to detach it from the iron, graphite, and other matters in which it is embedded. I can, however, show the different stages of the operations, and project on the screen diamonds made in this manner.

In Paris, recently, I saw the operation carried out by M. Moissan, the discoverer of this method of making carbon separate out in the transparent crystalline form, and I can show you the operations straight, as it were, from the inventor's laboratory. I am also indebted to the Directors of the Notting Hill Electric Lighting Co. and to the General Manager, Mr. Schultz, for enabling me to perform several operations at their central station, where currents of 500 amperes and 100 volts were placed at my disposal.

The first necessity is to select pure iron—free from sulphur, silicon, phosphorus, &c.—and to pack it in a carbon crucible with pure charcoal from sugar. Half a pound of this iron is then put into the body of the electric furnace, and a powerful arc formed close above it between carbon poles, utilising a current of 800 amperes at 40 volts pressure. The iron rapidly melts and saturates itself with carbon. After a few minutes' heating to a temperature above 4000° C.—a temperature at which the lime of the furnace melts like wax and volatilises in clouds—the current is stopped, and the dazzling fiery crucible is plunged beneath the surface of cold water, where it is held till it sinks below a red heat. As is well known, iron increases in volume at the moment of passing from the liquid to the solid state. The sudden cooling solidifies the outer layer of iron, and holds the inner molten mass in a tight grip. The expansion of the inner liquid on solidifying produces an enormous pressure, and under the stress of this pressure the dissolved carbon separates out in a transparent, dense, crystalline form—in fact, as diamond.

Now commences the tedious part of the process. The metallic ingot is attacked with hot nitro-hydrochloric acid until no more iron is dissolved. The bulky residue, consisting chiefly of graphite, together with translucent flakes of a chestnut-coloured carbon, black opaque carbon of a density of from 3·0 to 3·5, and hard as diamonds—black diamonds or carbonado, in fact, and a small portion of transparent colourless diamonds showing crystalline structure. Besides these, there may be carbide of silicon and corundum, arising from impurities in the materials employed.

The residue is first heated for some hours with strong sulphuric acid at the boiling point, with the cautious addition of powdered nitre. It is then well washed and allowed for two days to soak in strong hydrofluoric acid in the cold, then in boiling acid. After this treatment the soft graphite will disappear, and most, if not all, of the silicon compounds will be destroyed. Hot sulphuric acid is again applied to destroy the fluorides, and the residue, well washed, is repeatedly attacked with a mixture of the strongest nitric acid and powdered potassium chlorate, kept warm, but to avoid explosions not above 60° C. This ceremony must be repeated six or eight times, when all the hard graphite will gradually be dissolved, and little else left but graphitic oxide, diamond, and the harder carbonado and boart. The residue is fused for an hour in fluorhydrate of fluoride of potassium, then boiled out in water, and again heated in sulphuric acid. The well-washed grains which resist this energetic treatment are dried, carefully deposited on a slide, and examined under the microscope. Along with numerous pieces of black diamond are seen transparent colourless pieces, some amorphous, others with a crystalline appearance, as I have attempted to reproduce in diagrams. Although many fragments of crystals occur, it is remarkable that I have never seen a complete crystal. All appear broken up, as if on being liberated from the intense pressure under which they were formed they burst asunder. I have direct evidence of this phenomenon. A very fine piece of artificial diamond, carefully mounted by me on a microscopic slide, exploded during the night, and covered my slide with fragments. This bursting paroxysm is not unknown at the Kimberley mines.

On the screen I will project fragments of artificial diamond, some lent me by Prof. Roberts-Austen, others of my own make; while on the wall you will see drawings of diamonds copied from M. Moissan's book on the electric furnace. Unfortunately these specimens are all microscopic. The largest artificial diamond, so far, is less than one millimetre across.

Laboratory diamonds burn in the air before the blowpipe to carbonic acid; and in lustre, crystalline form, optical properties, density, and hardness they are identical with the natural stone.

Many circumstances point to the conclusion that the diamond of the chemist and the diamond of the mine are strangely akin as to origin. It is conclusively proved that the diamond has not been formed *in situ* in the blue ground. The diamond genesis must have taken place at great depths under enormous pressure. The explosion of large diamonds on coming to the surface shows extreme tension. More diamonds are found in fragments and splinters than in perfect crystals; and it is noteworthy that although many of these splinters and fragments are derived from the breaking up of a large crystal, yet in no instance have pieces been found which could be fitted together. Does not this fact point to the conclusion that the blue ground is not their true matrix? Nature does not make fragments of crystals. As the edges of the crystals are still sharp and unabraded the *locus* of formation cannot have been very distant from the present sites. There were probably many sites of crystallisation differing in place and time, or we should not see such distinctive characters in the gems from different mines, nor indeed in the diamonds from different parts of the same mine.

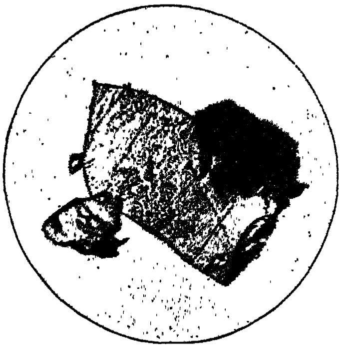

FIG. 5.—Diamond artificially crystallised from molten iron.

THE MECHANISM OF THE DIAMANTIFEROUS PIPES.

How the great diamond pipes originally came into existence is not difficult to understand in the light of the foregoing facts. They certainly were not burst through in the ordinary manner of volcanic eruption; the surrounding and enclosing walls show no signs of igneous action, and are not shattered nor broken even when touching the "blue ground." These pipes after they were pierced were filled from below, and the diamonds formed at some previous epoch too remote to imagine were erupted with a mud volcano, together with all kinds of débris eroded from the adjacent rocks. The direction of flow is seen in the upturned edges of some of the strata of shale in the walls, although I was unable at great depths to see any upturning in most parts of the walls of the De Beers mine.

Let me again refer you to the section through the Kimberley mine. There are many such pipes in the immediate neighbourhood. It may be that each volcanic pipe is the vent for its own special laboratory—a laboratory buried at vastly greater depths than we have reached or are likely to reach—where the temperature is comparable with that of the electric furnace, where the pressure is fiercer than in our puny laboratories and the melting-point higher, where no oxygen is present, and where masses of carbon-saturated iron have taken centuries, perhaps thousands of years, to cool to the solidifying point. Such being the conditions, the wonder is, not that diamonds are found as big as one's fist, but that they are not found as big as one's head. The chemist arduously manufactures infinitesimal diamonds, valueless as ornamental gems; but nature, with unlimited temperature, inconceivable pressure, and gigantic material, to say nothing of measureless time, produces without stint the dazzling, radiant, beautiful crystals I am enabled to show you to-night.

The ferric origin of the diamond is corroborated in many ways. The country round Kimberley is remarkable for its ferruginous character, and iron-saturated soil is popularly regarded as one of the indications of the near presence of diamonds. Certain artificial diamonds present the appearance of an elongated drop. From Kimberley I have with me diamonds which have exactly the appearance of drops of liquid separated in a pasty condition and crystallised on cooling. At Kimberley, and in other parts of the world, diamonds have been found with little appearance of crystallisation, but with rounded forms similar to those which a liquid might assume if kept in the midst of another liquid with which it would not mix. Other drops of liquid carbon retained above their melting-point for sufficient time would coalesce with adjacent drops, and on slow cooling would separate in the form of large perfect crystals. Two drops, joining after incipient crystallisation, would assume the not uncommon form of interpenetrating twin crystals. Illustrations of these forms from Kimberley are here to-night. Other modified circumstances would produce diamonds presenting a confused mass of boarty crystals, rounded and amorphous masses, or a hard black form of carbonado.

Again, diamond crystals are almost invariably perfect on all sides. They show no irregular side or face by which they were attached to a support, as do artificial crystals of chemical salts; another proof that the diamond must have crystallised from a dense liquid.

When raised the diamond is in a state of enormous strain, as I have already shown by means of polarised light. Some diamonds exhibit cavities which the same test proves to contain gas at considerable pressure.

The ash left after burning a diamond invariably contains iron as its chief constituent; and the most common colours of diamonds, when not perfectly pellucid, show various shades of brown and yellow, from the palest "off colour" to almost black. These variations accord with the theory that the diamond has separated from molten iron, and also explains how it happens that stones from different mines, and even from different parts of the same mine, differ from each other. Along with carbon, molten iron dissolves other bodies which possess tinctorial powers. One batch of iron might contain an impurity colouring the stones blue, another lot would tend towards the formation of pink stones, another of green, and so on. Traces of cobalt, nickel, chromium, and manganese—all metals present in the blue ground—might produce all these colours.

An hypothesis, however, is of little value if it only elucidates one half of a problem. Let us see how far we can follow out the ferric hypothesis to explain the volcanic pipes. In the first place we must remember these so-called volcanic vents are admittedly not filled with the eruptive rocks, scoriaceous fragments, &c., constituting the ordinary contents of volcanic ducts. At Kimberley the pipes are filled with a geological plum-pudding of heterogeneous character—agreeing, however, in one particular. The appearance of shale and fragments of other rocks shows that the mélange has suffered no great heat in its present condition, and that it has been erupted from great depths by the agency of water vapour or some similar gas. How is this to be accounted for?

It must be borne in mind I start with the reasonable supposition that at a sufficient depth[1] there were masses of molten iron at great pressure and high temperature, holding carbon in solution, ready to crystallise out on cooling. In illustration I may cite the masses of erupted iron in Greenland. Far back in time the cooling from above caused cracks in superjacent strata through which water[2] found its way. Before reaching the iron the water would be converted into gas, and this gas would rapidly disintegrate and erode the channels through which it passed, grooving a passage more and more vertical in the endeavour to find the quickest vent to the surface. But steam in the presence of molten or even red-hot iron rapidly attacks it, oxidises the metal and liberates large volumes of hydrogen gas, together with less quantities of hydrocarbons[3] of all kinds—liquid, gaseous, and solid. Erosion commenced by steam would be continued by the other gases, and it would be no difficult task for pipes, large as any found in South Africa, to be scored out in this manner. Sir Andrew Noble has shown that when the screw-stopper of his steel cylinders in which gunpowder explodes under pressure is not absolutely perfect,

1 The requisite pressure of fifteen tons on the square inch would exist not many miles beneath the surface of the earth.

2 There are abundant signs that a considerable portion of this part of Africa was once under water, and a fresh-water shell has been found in apparently undisturbed blue ground at Kimberley.

3 The water sunk in wells close to the Kimberley mine is sometimes impregnated with paraffin, and Sir H. Roscoe extracted a solid hydrocarbon from the "blue ground."

gas finds its way out with a rush so overpowering as to score a wide channel in the metal; some of these stoppers and vents are on the table. To illustrate my argument Sir Andrew Noble has been kind enough to try a special experiment. Through a cylinder of granite is drilled a hole 0·2 inch diameter, the size of a small vent. This is made the stopper of an explosion chamber, in which a quantity of cordite is fired, the gases escaping through the granite vent. The pressure is about 1500 atmospheres, and the whole time of escape is less than half a second. Notice the erosion produced by the escaping gases and by the heat of friction, which have scored out a channel over half an inch diameter and melted the granite along their course. If steel and granite are thus vulnerable at comparatively moderate gaseous pressure, is it not easy to imagine the destructive upburst of hydrogen and water-gas grooving for itself a channel in the diabase and quartzite, tearing fragments from resisting rocks, covering the country with débris, and finally, at the subsidence of the great rush, filling the self-made pipe with a water-borne magma in which rocks, minerals, iron oxide, shale, petroleum, and diamonds are churned together in a veritable witch's cauldron! As the heat abated the water vapour would gradually give place to hot water, which forced through the magma would change some of the mineral fragments into the now existing forms.

Each outbreak would form a dome-shaped hill, but the eroding agency of water and ice would plane these eminences until all traces of the original pipes were lost.

Actions, such as I have described, need not have taken place simultaneously. As there must have been many molten masses of iron with variable contents of carbon, different kinds of colouring matter, solidifying with varying degrees of rapidity, and coming in contact with water at intervals throughout long periods of geological time—so must there have been many outbursts and upheavals, giving rise to pipes containing diamonds. And these diamonds, by sparseness of distribution, crystalline character, difference of tint, purity of colour, varying hardness, brittleness, and state of tension, would have impressed upon them, engraved by natural forces, the story of their origin—a story which future generations of scientific men may be able to interpret with greater precision than we can to-day.

Who knows but that at unknown depths in the earth's metallic core beneath the present pipes there are still masses of iron not yet disintegrated and oxidised by aqueous vapour —masses containing diamonds, unbroken, and in greater profusion than they exist in the present blue ground, inasmuch as they are enclosed in the matrix itself, undiluted by the numerous rock constituents which compose the bulk of the blue ground. If this be the case a careful magnetic survey of the country around Kimberley might prove of immense interest, scientific and practical. Observations, at carefully selected stations, of the three magnetic elements—the horizontal component of direction, the vertical component of direction, and the magnetic intensity—would soon show whether any large masses of iron exist within a certain distance of the surface. It has been calculated that a mass of iron 500 feet in diameter could be detected were it ten miles below the surface. A magnetic survey might also reveal other valuable diamantiferous pipes, which owing to the absence of surface indications would otherwise remain hidden.

METEORIC DIAMONDS.

There is another diamond theory which appeals to the fancy. It is said that the diamond is a direct gift from heaven, conveyed to earth in meteoric showers. The suggestion, I believe, was first broached by A. Meydenbauer (*Chemical News*, vol. lxi. p. 209, 1890), who says:—"The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth's formation. The available localities of the diamond contain the residues of not very compact meteoric masses which may, perhaps, have fallen in historic ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river beds, while the fine light matrix has been swept away."

According to this hypothesis, the so-called volcanic pipes are simply holes bored in the solid earth by the impact of monstrous meteors—the larger masses boring the holes, while the smaller masses, disintegrating in their fall, distributed diamonds broadcast. Bizarre as such a theory may appear, I am bound to say there are many circumstances which show that the notion of the heavens raining diamonds is not impossible.

In 1846 a meteorite fell in Hungary (the "Ava meteorite") which was found to contain graphite in the cubic crystalline system. G. Rose thought this cubic graphite was produced by the transformation of a diamond. Long after this prediction was verified by Weinschenk, who found transparent crystals in the Ava meteorite. Mr. Fletcher has found in two meteoric irons—one from Youndegin, East Australia, and one from Crosby's Creek, United States—crystals absolutely similar to those in the Ava meteorite.

In 1886 a meteorite falling in Russia contained, besides other constituents, about 1 per cent. of carbon in light grey grains, having the hardness of diamond, and burning in oxygen to carbonic acid.

Daubrée says the resemblance is manifest between the diamantiferous earth of South Africa and the Ava meteorite, of which the stony substance consists almost entirely of peridot. Peridot being the inseparable companion of meteoric iron, the presence of diamonds in the meteorites of Ava, of Youndegin, and of Crosby's Creek, bring them close to the terrestrial diamantiferous rocks.

Hudleston maintains that the bronzite of the Kimberley blue ground is in a condition much resembling the bronzite grains of meteorites; whilst Maskelyne says that the bronzite crystals of Dutoitspan resemble closely those of the bronzite of the meteor of Breitenbach, but are less rich in crystallographic planes.

But the most striking confirmation of the meteoric theory comes from Arizona. Here, on a broad open plain, over an area about five miles diameter, were scattered one or two

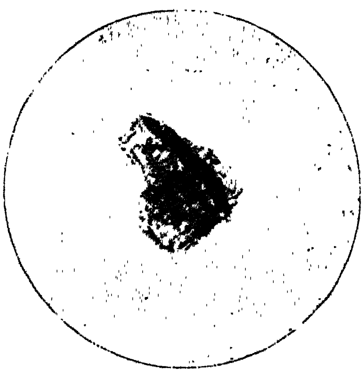

FIG. 6.—Diamond from the Canyon Diablo meteorite.

thousand masses of metallic iron, the fragments varying in weight from half a ton to a fraction of an ounce. There is little doubt these masses formed part of a meteoric shower, although no record exists as to when the fall took place. Curiously enough, near the centre, where most of the meteorites have been found, is a crater with raised edges three-quarters of a mile in diameter and about 600 feet deep, bearing exactly the appearance which would be produced had a mighty mass of iron or falling star struck the ground, scattered in all directions, and buried itself deep under the surface. Altogether ten tons of this iron have already been collected, and specimens of the Canyon Diablo meteorite are in most collectors' cabinets.

An ardent mineralogist, the late Dr. Foote, in cutting a section of this meteorite, found the tools were injured by something vastly harder than metallic iron, and an emery-wheel used in grinding the iron had been ruined. He examined the specimen chemically, and soon after announced to the scientific world that the Canyon Diablo meteorite contained black and transparent diamonds. This startling discovery was afterwards verified by Profs. Friedel and Moissan, who found that the Canyon Diablo meteorite contained the three varieties of carbon—diamond (transparent and black), graphite, and amorphous carbon. Since this revelation, the search for diamonds in meteorites has occupied the attention of chemists all over the world.

I am enabled to show you photographs of true diamonds I have myself extracted from pieces of the Canyon Diablo meteorite, five pounds of which I have dissolved in acids for this purpose—an act of vandalism in the cause of science for

which I hope mineralogists will forgive me. A very fine slab of the meteorite, weighing about seven pounds, which has escaped the solvent, is on the table before you.

Here, then, we have absolute proof of the truth of the meteoric theory. Under atmospheric influences the iron would rapidly oxidise and rust away, colouring the adjacent soil with red oxide of iron. The meteoric diamonds would be unaffected, and would be left on the surface of the soil to be found by explorers when oxidation had removed the last proof of their celestial origin. That there are still lumps of iron left at Arizona is merely due to the extreme dryness of the climate and the comparatively short time that the iron has been on our planet. We are here witnesses to the course of an event which may have happened in geologic times anywhere on the earth's surface.

Although in Arizona diamonds have fallen from above, confounding all our usual notions, this descent of precious stones seems what is called a freak of nature rather than a normal occurrence. To the modern student of science there is no great difference between the composition of our earth and that of extra-terrestrial masses. The mineral peridot is a constant extra-terrestrial visitor, present in most meteorites. And yet no one doubts that peridot is also a true constituent of rocks formed on this earth. The spectroscope reveals that the elementary composition of the stars and the earth are pretty much the same; so does the examination of meteorites. Indeed, not only are the self-same elements present in meteorites, but they are combined in the same way to form the same minerals as in the crust of the earth.

This identity between terrestrial and extra-terrestrial rocks recalls the masses of nickeliferous iron of Ovifak. Accompanied with graphite, they form part of the colossal eruptions which have covered a portion of Greenland. They are so like meteorites that at first they were considered to be meteorites till their terrestrial origin was proved. They contain as much as 1·1 per cent. of free carbon.

It is certain from observations I made at Kimberley, corroborated by the experience gained in the laboratory, that iron at a high temperature and under great pressure will act as the long-sought solvent for carbon, and will allow it to crystallise out in the form of diamond—conditions existent at great depths below the surface of the earth. But it is also certain, from the evidence afforded by the Arizona and other meteorites, that similar conditions have likewise existed among bodies in space, and that a meteorite, freighted with its rich contents, on more than one occasion has fallen as a star from the sky. In short, in a physical sense, heaven is but another name for earth, or earth for heaven.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE Institution of Mechanical Engineers was founded in 1847, and the present year is therefore its jubilee. As it came into existence as a Birmingham Society, and for the first thirty years of its career had its offices in that city, the removal to London being made in 1877, it was appropriate the jubilee meeting should be held there.

The meeting commenced on Tuesday of last week, July 27, and was brought to a close on the following Friday. There were two sittings for the reading and discussion of papers held on the Tuesday and Wednesday mornings, the President, Mr. Mr. E. Windsor Richards, occupying the chair. There were five papers on the agenda, but time was only found for the reading of the following three:—

"Some points in cycle construction," by F. J. Osmond, of Birmingham.

"The City of Birmingham Corporation Waterworks," by Henry Davey, of London.

"High-speed self-lubricating engines," by Mr. Alfred Morcom, of Birmingham.

The President also read an address, in which he gave particulars of the founding and early history of the Institution, together with short biographical notices of its past-presidents, from George Stephenson, who was the first, down to the present day.

Mr. Osmond, in his paper, discussed a few of the points to be observed in designing a successful bicycle. The principal causes of inefficiency, he said, were want of rigidity and undue friction. Of these two he considered the former the most important, and it is in this particular that cycles differ far more than in friction. The cause of loss is twofold. Firstly, the work done in springing the frame out of shape at each stroke of the foot is not spent in driving at the end of the down-stroke, but only in lifting the foot at the beginning of the up-stroke. Secondly, the springing of the frame causes a general condition of instability, due partly to the alteration of the balance through lateral movement of the pedals, and partly to the wheels being forced out of line, thereby causing the machine to swerve from side to side instead of running a true course. Purchasers of bicycles would do well to remember these facts. The rage for lightness is so great, that the makers, who have to follow the fashion, often cut material down to a point where there is only just enough metal to support the rider's weight under the varying conditions of running, the factor of safety being perilously small. As to rigidity, that is often abandoned altogether, or at any rate is only considered so far as it does not add to weight. Considering that the average purchaser only tests the machine by spinning the wheels and pedals to see if they run easily, one cannot wonder at this abandonment of a vital principle by the maker; but perhaps after the warning of Mr. Osmond, himself a noted manufacturer of cycles, sounder principles may prevail. In well-constructed machines friction is mainly due to the chain, and it is said that no more than 1 per cent. of the total power exerted by the rider has been lost. Even allowing a much higher factor than this, and doubtless it is too small, it will be seen to what perfection ball bearings have enabled the cycle maker to produce his machines. Mr. Osmond thinks that a mechanical efficiency of 95 per cent. would be nearer the truth, and this would be somewhat lower than the best record with which we are acquainted for the steam engine. The factor of safety for the bicycle frame is about $1\frac{1}{2}$, and if this is to be taken as including the ordinary conditions of riding, Mr. Osmond considers it true; but he states that a well.built frame will carry at least ten times its natural load without injury. The difference is due to the fact that the front part of the frame is exposed to shocks which must cause bending stresses near the head. If the two front tubes are arranged so that their axes intersect vertically above the axle of the front wheel, the stresses are only pure tension and compression so long as the force acting through the front axle is purely vertical. Such conditions are naturally not present when the wheel meets an obstacle, and bending stresses are therefore introduced. Other details of construction were discussed in the paper, and were illustrated by numerous wall diagrams. The discussion on this paper was confined to the suggestion by one speaker, Mr. Sharp, of Birmingham, that the weakening effect of brazing together the members of frames might be overcome by making a mechanical joint in which a hollow plug of suitable formation should be inserted in the ends of two tubes to be connected, the plug being corrugated on the outside, the idea being that the tube ends of the tubes containing the plug should be pressed into the corrugations. The joint would seem difficult to make, and one would fear that even if tightly made in the first instance it would be likely to work loose in time; but we are assured by the inventor that the device has given most promising results in actual practice. If these promises can be confirmed, the invention is of considerable value, as the brazing of steel undoubtedly causes deterioration of the metal.

Mr. Davey's paper gave an historical and general account of the Birmingham water works, together with cost of pumping, &c. This contribution led to practically no discussion.

Mr. Alfred Morcom's paper was far the most important of the three, and indeed was an excellent example of what a contribution to the proceedings of this Institution should be. The author is managing director of the firm of G. E. Belbis and Company, who have for some time past devoted their resources largely to the construction of what are generally known as high-speed engines, for which of late there has been a large demand owing to the spread of electric generation for lighting and power purposes. The engines of this firm differ from those largely manufactured for like purposes in the fact that the cylinders are double-acting, steam being taken on both sides of the piston. For very high speeds of rotation it has been often said to be necessary, in order to give smooth running, that there should be no reversal of stress on the working parts; steam, therefore, has generally been admitted only above the piston, so that the

stresses on the connecting-rods were always those of compression. With such an arrangement naturally a given cylinder only does half the work that can be obtained from a double-acting cylinder of the same capacity, and this leads to additional weight and space being required for the single-acting engine. For this reason it was the common practice, and still is to a large extent, to run the necessarily quickly rotating dynamo belt-gearing from a large engine making moderate revolutions, and occupying much space; but for a considerable time past the high-speed, single-acting engine, coupled direct, has been a formidable rival. The high-speed double-acting engine has also been growing in favour of late, and, as has been stated, undoubtedly has advantages. The dynamo-electric machine has certainly done one good thing—it has raised the standard of stationary engine design and manufacture enormously, just as the torpedo boat did for marine engineering. The chief features dealt with by Mr. Morcom in his paper were lubrication and vibration, the two great difficulties to be met in quick-turning engines. To effectually lubricate bearings a force-pump is employed, which continuously injects oil at pressure into the space between the shaft or journal and the bearing. The reciprocation of pressure of the shaft on the bearing assists the circulation of the lubricant for the following reason: when strain is above the piston, and the connecting rod is in compression, the journal will be pressing on the bottom brass—we put out of consideration any tendency of the shaft to bend—and, as a journal can never be an absolutely tight fit in its bearing, there will be a space between the top bearing and the shaft. Into this space oil is at once forced by the pressure-pump, and when the stress is reversed the film of oil remains during the whole of the up-stroke, because there is not time to squeeze it out from between the rubbing surfaces before the pressure is again released. The same thing, of course, applies to the bottom brass, and in this way there is always a liquid film of oil between the journal or shaft and the brass or bearing, and the two, therefore, never come in contact. Observed data support the latter view, as the wear on journals has been found to be inappreciable after considerable running; but perhaps the best testimony is that Prof. Kennedy, in an exhaustive test of one of these engines, found the mechanical efficiency of the machine to be 96·3 per cent. It will be seen that in this matter of distributing the oil on the bearing surfaces the double-acting engine has an advantage over the single-acting engine, where the pressure is always in one direction, and is never released while the engine is running, although it may be relaxed. In regard to vibration so much has been done lately, especially by the builders of torpedo craft, that not much is left to add. It may be said that Mr. Morcom is fully alive to the need for providing against the disturbance "due to couples produced by the changing momentum in the several lines of moving parts," and that occasioned by the obliquity of movement of the connecting-rod. He refers to Mr. Yarrow's admirable experiments, and considers the effect of crank angle and multiple cylinders. We have not, however, space to go into these problems, and must refer our readers to the original paper.

A long and interesting discussion followed the reading of the paper.

There were several excursions to neighbouring towns, where works were visited, speeches made, and luncheons eaten after the manner of meetings of this kind. One of the trips which attracted a great deal of interest was that to Coventry, where the much-discussed "motor-mills" where "horseless carriages" are made in such profusion, according to certain glowing accounts, were to be inspected. This establishment is said to be "the largest and best organised for the purpose in the country." To judge by what was seen in regard to work in progress, there need not be much fear that the country will be flooded by horseless carriages for some time to come yet.

A TROUBLESOME AQUATIC PLANT.

FOR several years past an aquatic plant known as the water hyacinth has been developing to such an enormous extent in the St. Johns River, Florida, as to cause serious apprehension in that region regarding its possible obstruction to navigation. About two years ago the War Department was asked to investigate the matter, and did so. In answer to urgent requests for exact information on the subject, the Department of Agriculture, on January 25, directed one of its agents, Mr. Herbert J. Webber, an assistant in the Division of Vegetable Physiology and Pathology, to visit the region and prepare a report covering the following points: (1) Historical notes regarding the plant, including its habitat, manner of growth, propagation, and anatomical and physiological characters; (2) an account of its introduction and spread in Florida; (3) the present distribution of the plant in the State, and its effect on navigation and commerce; and (4) possibilities of exterminating it. Mr. Webber's report has now been issued from the Government Printing Office, Washington, and is very exhaustive. The plant is mostly limited in its growth to sluggish fresh-water streams, lakes, &c., and the character of the water appears to have much to do with its growth. It can endure only a small percentage of salt, and is killed when it floats down into the sea-water. It is normally propagated by seeds and by stolons. Its introduction into the St. Johns River took place about 1890, when a number of plants were thrown into it. They grew there luxuriantly, producing beautiful masses of flowers which rendered the river attractive. At this time no one suspected that the plant would become a nuisance, and it was introduced at various points to beautify the river. In a short time it interfered very materially with navigation, making it, in fact, both difficult and dangerous. Its effect has been most disastrous to those engaged in the lumber trade and in the fishing industry. It is feared that eradication is impracticable, but suggestions are made as to possible methods for keeping the evil in check. Of these the one most in favour with the author is the use of a light-draught stern-wheel steamer, having a double bow or outrigger, which, being forced into a mass of plants, would cause them to gather towards the middle of the boat, where an inclined carrier would pick them up and deposit them in front of rollers driven by machinery, which would force the water from them, thus greatly reducing their bulk. The crushed material could be delivered to barges alongside, to be deposited where no injury could again result, or a cremator could be arranged on a barge alongside of the boat, and so save additional handling.

THEORY AND PRACTICE.[1]

I PROPOSE to speak to-day of the relative importance of theory and of practice in the arts; and especially, of course, in the art of medicine. It is said that Englishmen are falling behind other nations, and especially behind the German nation, in their perception of the value of theory in the practical arts. Now this is somewhat strange and inconceivable to us. Englishmen proudly feel in this year of the Greater Jubilee that their achievements in the conduct of life are not only great but incomparable. Not only has England become great as an empire, as the Roman Empire; it is great also in the achievements of the intellect: the land of Roger Bacon, of Francis Bacon, of Newton and Adams, of Berkeley, Locke and Hume, of Boyle, Priestley, Cavendish and Dalton, of Young and Faraday, of Harvey, Owen, and Darwin, need not be ashamed even before the brilliant nation of Descartes and Laplace, of Lavoisier and Cuvier, of Paré, Bichat, and Bernard. Nor will I forget to speak of our place in letters, wherein we acknowledge none as our masters; for it is of the gifts of imagination no less than of the gift of analysis that scientific theory is born. Can it be true, then, that with these endowments we are to fall behind in the practice of the arts because, as a nation, we have no due sense of the bearing of theory upon practice?

It cannot be doubted, I fear, that, in some departments of knowledge we are falling behind relatively if not absolutely; that we have failed to keep before ourselves a due sense of the value of theory, and have forgotten that, although in generalisation we should never lose our hold upon detail, nor lose our tact in converse with the manifold aspects of life, nor our memory of the devices whereby we must meet the incursions of contingencies often themselves incalculable, we shall nevertheless fall behind in the fight with reluctant nature if we do not incessantly revise our formulas in the light of progressive research on more and more general lines. We have perhaps forgotten that the work of Watt and Stephenson would have made little progress but for the great modern advances in thermodynamics in which, among others, are

[1] Abstract of an address delivered at the combined meeting of the Cambridge and Huntingdon, the East Anglian, and the South Midland Branches of the British Medical Association at Cambridge, by Prof. T. Clifford Allbutt, F.R.S. Abridged from the *British Medical Journal*.

eminent the names of our own Joule and Thomson; we have perhaps forgotten that, brilliant as is the work of the modern electrician, his achievements depend upon the theoretical researches of disinterested students such as Faraday and Hertz; we have perhaps forgotten, as a contributor to NATURE said last year, that "Kekulé first gave definite form to Frankland's conception of valency, and his application of this idea to the study of the carbon compounds was nothing less than epoch making. Out of this conception grew the famous theory of cyclic compounds which has been prolific to an extent almost unparalleled in the history of pure science, and which on the practical side has made Germany what it is in the domain of organic chemical technology." In our own art, proud as we may be of Jenner and Lister, yet we have to remember that the recent advances in the theory of infection are due rather to the schools of Pasteur and Koch than to our own; while the scarcely less remarkable advance in the discovery and manufacture of new drugs is almost entirely of foreign growth.

How comes it, then, that if we are a people of contemplative as well as of practical gifts, we have so far forgotten ourselves as to fall behind—in many respects far behind—in discovery and, consequently, in practical success? Some of the reasons are not far to seek. The most important of all is, no doubt, that Englishmen, by their practical genius—that is, by their gifts of adventure, of restless energy, of perception of contingency and accident in daily life, and of a correlative readiness of resource—have achieved so much in the mastery over man and nature, that in their day of prosperity they have lost reverence for those qualities of the mind upon which the development of science and art must in the main depend. The system of practical rules and maxims which they have built up are now becoming obsolete, and need revision in the face of larger requirements; as the rules of the first steam engineers had to be revised in the face of the discovery of the mechanical equivalent of heat, a discovery not made by engineers, but given to them. That practical rules shall from time to time be brought up for revision, and be remodelled on the lines of advancing theoretical research, is essential to the continuance of our progress and of all successful practice.

Another reason of our defect is that our people are above all things efficient in the manual arts. Now the manual arts are less open to theoretical inadequacy than the chemical arts or the art of medicine; the complexity of the conditions is less, the incursions of incidental contingencies are fewer, and the necessary calculations are both simpler and in their effects more immediate and obvious. Hence we are tempted to assume that the ready calculations of the practical man are roughly sufficient for all other arts, as they are for the manual; and that they pay as promptly and obviously. But this is not the case; as we pass from the manual arts to the chemical, let us say, or to the physiological, we have to deal with causes of much greater complexity, contingencies are multiplied and are less and less easily foreseen; thus it is that even valid generalisations have to wait for the fulfilment, or practical fulfilment, of a number of secondary verifications before they can be utilised; meanwhile they are as useless to the practical man as, for example, the more general laws of meteorology are to the navigator. Now thus to wait means time and men's lives; both must be spent without reward until a considerable block of discovery is made, verified and applied. Research, then, in the chemical and biological sciences, at any rate, cannot be self-supporting, but must rest on large endowments. The American people and the people of Lancashire and Yorkshire now see this more or less darkly, and they are endowing research with a generous hand; but national aid—liberally given in the United States as well as in France and Germany—is refused in England, and will be refused until the nation, aroused by the urgency of pressing need, determines no longer to be governed by the clerks of the Treasury.

Another reason for our defect is the want of a bridge between the contemplative and the practical man. The man of abstract speculation, the experimenter absorbed in his single desire to wrest her secrets from nature begins at the opposite pole from him whose whole activity is absorbed in industrial adventure.

It is not that theory and practice are essentially opposed, but that the man of theory loves to move in the larger sphere of those more general laws which express the order of phenomena in their wider orbits, and therein to neglect those incidental and subordinate causes which, after all, are the main concerns of the journeyman. It is as though a mathematician would work at his problems, neglecting friction; a political economist at the secular aspects of industrial problems, without taking account of the passions of mankind; a hydrographer at the sweep of the great systems of oceanic currents, without taking account of the whirlpools, races, and under-currents which modify them on every coast and in every gulf; yet the journeyman is mainly concerned with the irregularities of which the abstract-thinker may be ignorant. While, therefore, the theorist may rightly reproach the practical man with the narrowness of his outlook, the practical man may usefully retort that a theory which only accounts for the larger recurrent cycles is imperfect, even as a theoretical statement; and that in respect of cases not only are the wider laws to be formulated, but also the smaller periods of those many contingencies and perturbations which, in a complete theoretical statement, have all to be reckoned with. If we forecast our weather on barometrical pressure alone, we shall be disappointed; a complete theory of meteorological cases must comprehend formulas for the phenomena of moisture, of temperature, of electricity, of oceanic currents, and so forth. A meteorologist, who pursued his studies in the Islands of the Blest, might become a very learned philosopher, but would be a very untrustworthy guide to the weather; and one who should work, say at physics or physiology, in a university where engineering and medicine are unknown, would likewise fall out of touch with the practical ends which are the ultimate purpose of all science. There is a casuistry in the arts, as there is in morals; particular instances are apt to elude general principles: and although it be true that, as with statistics, by taking a sufficiently large number of instances we may eliminate incidental causes, yet this is precisely what the practical man must avoid.

We shall not, as practical men, whether in medicine or in morals, allow ourselves to be blinded by the light of the brilliant generalisations of the laboratory and the lecture-room, helpful as this light is, to the value of the empirical rules which have been painfully gathered together in the trials and errors of generations of men. As Oliver Wendell Holmes says, "Science is a first-rate piece of furniture for a man's upper chamber if he has common sense on the ground floor; but if a man has not got plenty of good common sense, the more science he has the worse for his patient." A sagacious man is not to be driven too readily out of his rules, absurd as they may seem.

On the other hand, while clinging to our rules until something better is demonstrated to us, we practical men must not forget day by day to submit our empirical laws to revision; we must bear in mind that empiricism is science without roots. We are right in our paradoxical tolerance of anomalies; we are right in our instinct that broad generalisations are too often impracticable in that they may not take account of incidents and contingencies, but this is not all.

In England the man of thought and the man of action have been too much apart; thus both have suffered. So long as our national work has been pioneering work, rough practical rules of thumb, applied with indomitable energy, have been irresistible; but as industrial pursuits become more complex, and the sciences concerned also more complex, rule of thumb is no longer wide enough or refined enough; methods based upon wider theoretical considerations have to be introduced.

We cannot stand still; we must advance, revolve, or degenerate; pathology must be renewed by the new meanings and new bearings of biology and by a comparative method, embracing in experience no less than the diseases of all living things. We must work out, or obtain from our fellows who work them out, the mechanical and chemical laws which underlie all life, and by a method of exclusion ascertain what the residuum is which may be peculiar to living matter. We shall not assume vitality as a principle, and grudgingly admit a little chemistry and physics to fill up a few holes in a threadbare principle. Medicine depends upon theoretical advance, not in physiology only, but in all sciences; and upon the practice of many, as upon practical optics in respect of our microscopes, upon mechanics in respect of our graphic machinery and so forth; as we change we change our circumstances, and circumstances reacting on us change us again; so that we depend upon a highly compound process of advance, and need theoretical reinforcement from all sides.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. WILLIAM ESSON, F.R.S., Deputy Savilian Professor of Geometry in the University of Oxford, has been appointed to succeed the late Prof. Sylvester as Savilian Professor.

DR. ARTHUR A. RAMBAUT, Royal Astronomer of Ireland, has been appointed Radcliffe Observer at Oxford, in succession to the late Dr. E. J. Stone, F.R.S.

THE John Lucas Walker Studentship at Cambridge, having an annual value of 250*l.* and tenable, under certain conditions, for three years, will be awarded in October next. The holder of the studentship is required to devote himself (or herself) to original research in pathology. Applications should be sent, before October 15, to Dr. A. A. Kanthack, Pathological Laboratory, Cambridge, to whom also requests for further information should be addressed.

THE following resolution, with reference to the London University Commission Bill, has been adopted by the Technical Education Board of the London County Council: "That the Board, being satisfied that the Bill now before Parliament makes adequate provision for inclusion within the scheme of the University of duly-qualified teachers and students in the polytechnic institutes (and other institutions aided by the Board), and that the special interests with which the Technical Education Board is concerned have been duly safeguarded, hereby approves the Bill and expresses its desire that it may be passed into law this session."

IN the House of Commons on Monday, Mr. Balfour announced with very great regret that he believed it to be impossible to take the London University Commission Bill in the course of the present Session. He felt to the full the objections as to leaving over for another year the settlement of a question in which a large number of independent educational bodies were concerned, and on which, speaking broadly, they had come to an agreement. But he recognised at the same time that there was serious opposition taken to it in its present shape, and the Government could not face the expenditure of time necessary to deal with the measure in the present Session. The Government must therefore postpone the Bill. He earnestly hoped that next year, at all events, the Government would be in a position to settle this long-standing and perplexing controversy.

THE circumstances and the legislative proceedings which resulted in the reconstitution of the French Universities were described in NATURE rather more than a year ago (vol. liv. p. 64, May 21, 1896). The Paris correspondent of the *Times* now reports that, under the law which has come into force, decrees have just been issued for the government of the Universities. Each University is to have a council, consisting of the rector, the heads of faculties, and two delegates of each faculty elected triennially by the professors. The council, subject in certain cases to the approval of the supreme education council, will have control over the teaching, discipline and property of the University. It will, however, have merely a consultative voice on the finances, and on the creation, abolition, or transformation of professorships, for the State will continue to pay the stipends. The maintenance of buildings, on the other hand, will fall on the University, and must be defrayed from students' fees or from endowments. The State takes the fees for examinations and State diplomas, but all other fees go to the University treasury. It will, therefore, be to the interest of each University to attract as many students as possible. The receipts of Paris University are estimated at 600,000 francs, and of Lyons at 130,000 francs, but Besançon and Clermont have at present only 700 francs or 800 francs, and will obviously have to solicit subsidies either from the State or from local bodies. Failing this, the smaller Universities are likely to succumb. One of the features of the new system is that a student will, as in Germany, be able to migrate from one University to another without lengthening his studies or delaying his degree.

HER Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships, for the year 1897, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result directly in work of scientific importance.

	Nominating institution.	Scholar
1	University of Edinburgh	Longfield Smith
2	University of Glasgow ...	James Muir
3	University of St. Andrews	Harry McDonald Kyle
4	University College, Dundee	Sydney A. Kay
5	Mason College, Birmingham	Gilbert Arden Shakespear
6	University College, Bristol	Chas. Henry Graham Sprankling
7	Yorkshire College, Leeds	Harold Albert Wilson
8	University College, Liverpool	William Augustus Caspari
9	University College, London	Percy Williams
10	Owens College, Manchester	John Henry Grindley
11	Durham College of Science, Newcastle-upon-Tyne	Robert Railton Hallaway
12	University College, Nottingham	Richard S. Willows (*conditional appointment*)
13	Firth College, Sheffield	Ernest Clark
14	University College of South Wales, Cardiff	Maria Dawson
15	Queen's College, Belfast	William Alexander Osborne
16	McGill University, Montreal	James Lester Willis Gill
17	Queen's University, Kingston, Ontario	Frederick John Pope
18	University of Sydney	Tom Percival Strickland
19	University of Melbourne	Walter Rosenhain

The following scholarships, granted in 1896, have been continued for a second year on receipt of a satisfactory report of work done during the first year:—

	Nominating institution	Scholar	Places of study
1	University of Glasgow	William Craig Henderson	Cavendish Laboratory, Cambridge
2	University of Aberdeen	Alexander Ogg	University of Göttingen
3	Mason College, Birmingham	Thomas Slater Price	University of Leipzig
4	University College, Bristol	Emily Comber Fortey	University College, Bristol, and Owens College
5	Yorkshire College, Leeds	Harry Medforth Dawson	University of Berlin
6	University College, London	Joseph Ernest Petavel	University College, London, and Davy-Faraday Laboratory
7	Owens College, Manchester	John Leathart Heinke	Owens College and University of Tübingen
8	Durham College of Science, Newcastle-upon-Tyne	John Armstrong Smythe	University of Göttingen
9	University College, Nottingham	George Blackford Bryan	Cavendish Laboratory, Cambridge
10	University College of Wales, Aberystwyth	Spencer William Richardson	Cavendish Laboratory, Cambridge
11	Queen's College, Galway	John Henry	Cavendish Laboratory, Cambridge
12	University of Toronto	Arthur Melville Scott	University of Göttingen
13	Dalhousie University, Halifax, Nova Scotia	Douglas McIntosh	Cornell University
14	University of New Zealand	John Angus Erskine	University of Berlin

The following scholarships, granted in 1895, have been exceptionally renewed for a third year:—

	Nominating institution	Scholar	Places of study
1	University of Glasgow	Walter Stewart	Universities of Glasgow and Berlin
2	McGill University, Montreal	Robert Owen King	McGill University and Harvard University
3	University of New Zealand	Ernest Rutherford	Cavendish Laboratory, Cambridge

The Scholarships Committee consisted of Sir Henry Roscoe, chairman; Lord Rayleigh, Lord Kelvin, Lord Playfair, Mr. Mundella, Dr. William Garnett, and Sir J. Norman Lockyer.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 6.—Diffusion constants of some metals in mercury, by G. Meyer. A dilute zinc amalgam was poured into two glass tubes, one of which was closed by fusion at the bottom, while the other was provided with a fine net of platinum wire, which did not allow the amalgam to penetrate. The latter tube was inserted in a beaker containing H_2SO_4. The two tubes were joined by a siphon. On passing a current through, with a kathode of platinum immersed in the beaker, the lowest layer of amalgam next the net was deprived of zinc and reduced to the state of pure mercury. The concentration of the top layer was estimated by the E.M.F. between the two tubes, and the rate of fall of the concentration was used to determine the diffusion constant of the zinc in the mercury. It was found to be 0·087 in cm.-hours for zinc, 0·065 for cadmium, and 0·057 for lead.—Electric vibrations in the Lecher system, by R. Apt. The author investigates the influence of the primary exciter in a Lecher wire system upon the form and intensity of the oscillations. There are nodes at the bridges over the secondary wires and at the spark gap. A maximum of intensity is obtained when the divisions of the secondary circuit are in resonance amongst themselves, and with the two divisions into which the primary system is divided by the spark gap. If the spark passes in a gas, the intensity varies directly with the pressure.—Kathode and Röntgen rays, by J. Precht. Goldstein's "canal rays," produced by perforating the kathode, are kathode rays which are not deflected by the magnet. They are distinguished from Röntgen rays by the absence of photographic and fluorescent actions. Röntgen rays have a condensing effect upon water vapour, and they increase the resistance of a selenium cell by 32 per cent. A portion of the rays proceeding from discharge tubes is not a wave motion, since the extent of absorption of the Röntgen rays by paper depends upon the duration of the radiation. Perhaps this part of the action is of a purely electrical nature. Röntgen rays show distinct interference phenomena, and are therefore partly due to some kind of wave motion.—Measurements of the interference of direct X-rays and others reflected at grazing incidence gave wave-lengths of 370 to 830 $\mu\mu$. These are near the limits of the visible spectrum, and since these rays are practically invisible they are probably longitudinal for the most part.—Arc lamps with amalgam terminals, by E. Gumlich. Arons has constructed an arc lamp in which the electrodes consist of mercury. If amalgams could be used instead, they might be made to yield an intense spectrum due to the body combined with the mercury. The author took special precautions to avoid oxidation during the filling process, and constructed a successful cadmium amalgam lamp which gives a brilliant red line. To avoid loss of light due to the opaque deposit round the kathode, the electrodes are placed in side tubes, and the light is projected down the main tube by a mirror.

No. 7.—Damping effect of a magnetic field on rotating insulators, by W. Duane and W. Stewart. The phenomena of damping of such bodies as sulphur and paraffin when rotating in a magnetic field, described some time ago by Duane, are, after all, found to be due to traces of iron. This can only be proved, however, by distilling these bodies five times and noting the absence of the damping. The latter will persist even after all chemical reactions have failed to indicate the presence of iron. The damping test is fifty times more delicate than chemical analysis.—Conductivity of carbon for heat and electricity, by L. Cellier. In metals the electric and thermal conductivities have an approximately constant ratio, if the specific heat per unit volume is taken into account. Measurements made with graphite, retort carbon, and various kinds of arc light carbons show that there is no correspondingly simple relation in the case of carbon. Whilst in the case of metals the ratio between the two conductivities varies between $0·07 \times 10^6$ and $0·12 \times 10^6$, it varies between the limits $1·8 \times 10^6$ and $53·72 \times 10^6$ in the carbons studied. The relation referred to seems, therefore, only to hold good for metals.—Magnetic deflection of kathode rays and its dependence upon the discharge potential, by W. Kaufmann. The extent to which kathode rays are deflected by a magnetic field is usually considered to depend upon the gas, the degree of exhaustion, and the dimensions of the tube. The author claims to have shown that all these conditions are only of secondary importance, and owe their influence exclusively to the fact that they affect the discharge potential between the anode and the kathode. The magnetic deflectibility is inversely proportional to the square root of the difference of potentials.—Determination of the period of electric oscillations, by Margaret E. Maltby. This paper contains the description of a new method for determining the ratio v between the electrostatic and electromagnetic units. It is based upon the principle of the Wheatstone bridge. The capacities of the two halves of an electrometer form two branches, and a known capacity and a known resistance form the third and fourth branches respectively. The mean value of three series of measurements was $3·015 \times 10^{10}$, which differs from the best results extant by an amount well within the errors of observation.—A relation between the electrical, chemical, and geometrical properties of a crystal, by J. Beckenkamp. The genesis of the electrical poles is connected with the chemical structure of a crystal. This is evidenced by such facts as that in aragonite treated with HCl, and in baryta treated with H_2SO_4, the directions of greater solubility are opposed to the positive direction of the electrical lines of force.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 19.—Lord Kelvin in the chair.—The President presented to the successful Fellows the prizes awarded by the Council, and in a few words described the nature and value of the work done by each.—Mr. J. W. Inglis read an interesting popular account of his experience of Indian earthquakes during a residence in that country of nearly twenty-five years.—Dr. C. G. Knott read a paper on relations among various types of magnetic strains. The first note dealt with the relation between the elongation in iron or nickel in a magnetic field, and the twist produced in the same, when, in addition, an electric current was passed through the material in the direction of the magnetisation. Data recently obtained were used in testing a formula, given by the author in a previous paper (*Trans.* R.S.E., vol. xxxv., 1888), for the twist in a cylinder under longitudinal and circular magnetising process. The striking characteristics of the twist phenomenon were reproduced, *e.g.* the maximum twist in iron occurring in a field lower than the field for maximum elongation, and the maximum twist in nickel, although in this metal there is no maximum or minimum point in the elongation-curve. The second note gave an account of experiments elucidating the character of the strain in a nickel tube when magnetised. There was a small but measurable diminution of volume produced in the material of the tube, and a (comparatively) large apparent diminution of volume indicated in the outer dimensions of the tube, when it was plugged up at both ends. The elongation in the direction of magnetisation having also been measured, the data were used to calculate the radial displacements, usually outwards, of the inner and outer surfaces of the tube. In a tube of external radius 1·39 c.m. and internal radius ·477 c.m. these displacements, in a field of 200, of the corresponding surfaces were 9·6 and 1·9, and in a field of 500, 14·7 and 2·3, the unit being 10^{-6} c.m. The probable nature of the strain at different parts was considered.—A very interesting paper, giving an account of the expedition from Edinburgh to observe the total eclipse of the sun on August 8, 1896, was read by Prof. Copeland and Mr. Ramsay.—The President then adjourned the meeting till November.

DUBLIN.

Royal Dublin Society, June 16.—Prof. W. J. Sollas, F.R.S., in the chair.—Mr. J. R. Wigham described a new method of conferring distinguishing characteristics upon illuminating buoys and beacons for harbours, estuaries, and rivers.—Mr. Richard J. Moss read a paper on the cause of the death of fish in the Flesk River and Killarney Lake during the recent bog-flow in the County of Kerry.—Mr. William Barlow read a paper on a mechanical cause of homegeneity of structure and symmetry geometrically investigated, with special application to crystals and to chemical combination. This paper was communicated by Prof. W. J. Sollas, F.R.S.—Prof. D. J. Cunningham, F.R.S., gave a lantern demonstration of the deep origins of certain of the cranial nerves in the chimpanzee and orang-utan.—The following paper was omitted from the list of those read at the meeting of May 19: A spectrographic analysis of iron meteorites, siderolites, and meteoric stones, by Prof. W. Noel Hartley, F.R.S., and Mr. Hugh Ramage.

PARIS.

Academy of Sciences, July 26.—M. A. Chatin in the chair.—The gnomon of the Observatory and the old values of the toise: recovery of the Picard toise, by M. C. Wolf.—Establishment of a uniform state in a pipe of circular section, by M. J. Boussinesq.—On the composition of drainage water, by M. P. P. Dehérain. The formation of nitrate from the nitrogenous stock in the soil, by the action of organisms, is greatly accelerated by moisture; hence the advantage of irrigation where possible.—Researches on the state in which elements other than carbon occur in cast iron and in steel, by M. H. Ad. Carnot and Goutal. A continuation of a previous paper. Manganese combines as far as possible with the sulphur and silicon, any excess being simply dissolved in the iron. No compound of copper or nickel appears to be formed. Chromium is present in combination with both carbon and iron. Tungsten forms a definite compound, Fe_3W; molybdenum, Fe_3Mo_2.—On the explanation of an experimental result attributed to a magnetic deviation of the X-rays, by Sir G. G. Stokes. Some remarks on an observation of M. G. de Metz. The X-rays, as a mode of vibration of the ether, are not susceptible of deviation by a magnet; the kathode rays, on the other hand, consisting of a stream of electrified particles, are affected by the magnet. The kathode rays, moreover, are stopped by an air layer, and will only be able to affect a fluorescent screen as the vacuum is increased. The experiments of M. de Metz find a very simple explanation in these facts.—On the toxicity of the perspiration of a healthy man, by M. L. Arloing. Experimental results are given clearly showing the toxic action of normal perspiration.—Remarks on the preceding paper, by M. Berthelot.—On phthalic green, its preparation and constitution, by MM. A. Haller and A. Guyot. The formation of this colouring matter by the action of zinc chloride upon dimethylaniline and phthalyl chloride, is shown to depend upon the presence of phthalyl tetrachloride ($C_6H_5.CCl_3.COCl$) in the latter. Starting with this tetrachloride instead of the dichloride, yields of from 60 to 95 per cent. of the colouring matter are obtained, the constitution of which is different from that assigned to it by its discoverer (Otto Fischer).—On a generalisation of the problem of representation in three dimensions, by M. Émile Cotton.—The natural rotatory dispersion of quartz in the infra-red, by M. R. Dongier. The experimental method used gives results of a higher order of accuracy than any previously recorded: and no formula for the rotatory dispersion of quartz deduced from theoretical considerations will include both the visible spectrum and these results for the infra-red.—On the transformation of the X-rays by metals, by M. G. Sagnac. Different metals exert a selective absorption upon the X-rays. At the same time, the surface layer of the metal emits new rays which are transmitted through mica, aluminium, and black paper with much greater difficulty than the X-rays themselves.—On the veiled appearance of photographs taken with the X-rays, by M. P. Villard. The effect produced is not due to rays which have traversed all obstacles, since it is obtained under really opaque substances. The fluorescence of the surrounding air appears to be the source of the second image, and great difficulties are encountered for this reason in the radiography of a thorax.—Action of the X-rays upon the temperature of animals, by M. L. Lecercle. The cutaneous and rectal temperatures are both modified in the same direction by the X-rays, the temperature being at first lowered, but afterwards rising.—Researches on the nickel-steels. Expansions at high temperatures, the electrical resistance, by M. C. E. Guillaume. The results obtained for the variation of the electrical resistance with temperature show that this cannot be considered as a simple consequence of the expansion.—On the spectrum of the lines of carbon in fused salts, by M. A. de Gramont.—Relation between the polymerisation of liquid substances and their dissociating power upon electrolytes, by M. Paul Dutoit and Miss E. Aston. An experimental study of the electrical conductivities of some salts dissolved in propionitrile, acetone, methyl-ethyl-acetone, methyl-propyl-acetone, and nitroethane, all of which may be considered as polymerised liquids.—On a new group of amidines, by M. Fernand Muttelet.—On a method of estimating acetylene, generally applicable to hydrocarbons of the formula $R.C:CH$, by M. Chavastelon. By the action of acetylenic hydrocarbons upon an aqueous or alcoholic solution of silver nitrate, two molecules of nitric acid are set free for each molecule of acetylene absorbed. The estimation of such hydrocarbons is thus reduced to a simple titration of an acid.—On the estimation of lime, aluminium, and iron in mineral phosphates, by M. L. Lindet.—On the absorption of oxygen in the decolorisation of wine, by M. J. Laborde.—Influences exercised by the pathological state of parents upon their descendants, by M. A. Charrin.—Bacteriological study of ambergris, by M. H. Beauregard.—The persistence of the activity of rennet at low or high temperatures, by MM. L. Camus and E. Gley.—On a new form of the buccal apparatus of the Hymenoptera, by M. J. Pérez.—On a new Myxosphoridia of the family of Glugeïdea, by M. Louis Léger.—On the carboniferous ground in the neighbourhood of Mâcon, by M. A. Vaffier.—On the marcasite of Pontpéan, and on the regular grouping of marcasite, pyrites, and galena, constituting pseudomorphs of pyrrhotine, by M. A. Lacroix.—On some new applications of the oscillating current in electric therapeutics, by M. le Dr. G. Apostoli.

PAMPHLETS AND SERIALS RECEIVED.

PAMPHLETS.—Royal Gardens, Kew: Hand-List of Tender Monocotyledons, excluding Orchideæ, cultivated in the Royal Gardens, Kew, 1897 (London).—The Mammoth Cave of Kentucky: Dr. Hovey Call (Louisville, Morton).—The Birds of Colorado: W. W. Cooke (Fort Collins, Col.).—Report of the International Meteorological Conference, Paris, 1896 (Eyre).

SERIALS.—Journal of the Royal Statistical Society, June (Stanford)—Journal of the Chemical Society, July (Gurney).—Morphologisches Jahrbuch, 25 Band, 2 Heft (Leipzig, Engelmann).—Bulletin of the Natural History Society of New Brunswick, Vol. xv. (St. John).—L'Anthropologie, May and June (Paris, Masson).—Notes from the Leyden Museum, January and April (Leiden).—Natural Science, August (Dent).—Zeitschrift für Physikalische Chemie, xxiii. Band, 3 Heft (Leipzig, Engelmann).

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THURSDAY, AUGUST 12, 1897.

THE BREEDING OF SEA FISHES.

The Life-Histories of the British Marine Food-Fishes. By W. C. McIntosh and A. T. Masterman. Pp. 516. (London: Clay and Sons, 1897.)

THE pursuit of economic zoology has never been so keenly taken up in this country as has the corresponding aspect of botany. Whether it is that the purely intellectual problems of zoology are relatively more fascinating than those offered by the study of vegetables, or owing to some more recondite reason, it is certain that zoologists make less capital out of the practical application of zoological science to human needs than do the botanists. There is a fine field open for an economic entomologist who has the energy to avail himself of the endless variety of new material, in the form of "noxious insects," which is almost daily discovered in our remoter colonies and tropical territories. The life-history of the animals which serve man as food is another and equally important branch of economic zoology.

In so far as fishes are concerned, there is relatively a good deal of activity among British zoologists in regard to this matter. The explanation of this activity is to be found in the fact that both the British and Colonial Governments have instituted highly salaried "inspectorships" and "commissionerships" of fisheries, and there is a chance that here and there a zoologist, who has written a book on fishes, will be appointed to one of these posts instead of the more usual needy politician or poor relation of a peer. Moreover, since the great Fisheries Exhibition of 1883, laboratories have been organised at different points on the British coast, by the aid of local or imperial funds, for the purpose of obtaining that knowledge of the ways and habits of marine food-fishes, which is a necessary preliminary to legislation in regard to modes and times of fishing and the general regulation of the fisheries industry.

No one has been more active than Prof. McIntosh, of St. Andrews, in building up a sound scientific knowledge of the breeding and habits of marine food-fishes. It is a matter for congratulation that he should have determined to bring together the results of work done under his auspices in a handy volume. He has obtained the co-operation of an able young zoologist, Mr. A. T. Masterman, and the result is a book which, in many ways, resembles that recently published by Mr. Cunningham on British marketable fishes (Macmillan, 1896), but has its own distinctive character and scope. The volume by Prof. McIntosh and Mr. Masterman appears to be less directly addressed to the general public than that of Mr. Cunningham, and is very largely, as the authors state in their preface, founded upon the large quarto memoir, by McIntosh and Prince, published in the *Transactions* of the Royal Society of Edinburgh. Other sources are, however, made use of, and the researches of Cunningham and of Holt, who carried out their investigations as officers of the Marine Biological Association of the United Kingdom, are very freely quoted. Recent investigations by German, French and Italian naturalists are also duly noticed. The book is thus (except for the lack of bibliographical references) a valuable guide to the present state of knowledge as to the breeding of marine fishes, and by the professional naturalist will be found to serve in some respects as a supplement to the book produced by Mr. Cunningham under the direction of the Marine Biological Association.

A few words of criticism suggest themselves. The matter brought together in such a book as the present necessarily consists of a great variety of detail as to the superficial appearance of many different species of fishes at various stages of growth from the egg, as well as of observations on the eggs themselves. It is difficult to give any consistent form or purpose to the exposition of such details, since morphology is not the subject-matter of the treatise. Lithographic plates, with many coloured figures, are used by the authors to bring details of outline and colour before us. But it must be admitted that at present the subject is in a very primitive condition, when all or nearly all that we can hope for is a disconnected series of observations. It will be the work of later days, after a much greater number of observations has been made, to bring the facts together under larger and smaller generalisations.

Under these circumstances it is surely a mistake of the authors to say, as they do, that McIntosh's and Prince's "Researches" "may be said to have attempted for Teleosteans what the lamented Frank Maitland Balfour did for Elasmobranchs." The resemblance seems to me to be absolutely wanting. Balfour described, by means of sections, the cellular embryology of "an Elasmobranch," using only about six species, according to convenience, in his work. His object was not to describe the superficial appearance of young Elasmobranchs of all kinds, and he did not do it, or make any pretence of doing it. His object was to trace the genesis of the organs of the vertebrate body, and he made discoveries of fundamental importance for vertebrate morphology as to the origin of the fins, the notochord, the somites, and the renal organs. McIntosh and Prince have not attempted any work of the kind. They simply give figures of transparent eggs and larvæ of Teleosteans; and whilst thus adding to the observed material of "natural history," can not be said, any more than can the authors of the present volume, to have arrived at a single conclusion of importance to morphology, or to have worked with either the technical methods or the scientific aim of Frank Balfour.

Although one must maintain that such work as that recorded in the present book, and in the "Researches" of McIntosh and Prince, differs in every way from that done by Balfour for Elasmobranchs, one does not imply that it is not useful and excellent work of its kind—another kind. The morphology of the Teleostean as determined by embryology is a much more laborious task than the sketching of pigment-spotted embryos, and has been but very partially attacked as yet; though Grassi, Ryder, Harrison and others have carried on the work of the older observers in regard to such important points as the vertebral column and fin-skeleton.

In their preface the authors say that the life-history of

eighty or ninety species of British marine food-fishes are dealt with in their volume.

"Then (in 1883) the life-history of not a single British marine food-fish was known, at least from observations in our country. In the present work between eighty and ninety species are dealt with, the majority of the important forms more or less exhaustively."

This is obviously an error. From some points of view, it may be convenient to regard every marine fish as a "food-fish." The economic importance of observations on the stickleback is increased if we reckon that pugnacious mite as a "food-fish," and a list of contributions to the solution of practical fishery problems is, by such reckoning, enlarged to imposing dimensions. But in the ordinary sense of the term "food-fish," so many as eighty do not exist in British waters, and only a fractional part of these have any economic importance. The word "exhaustively" is also open to some objection; but as we are given the choice of "more" or "less" in relation to it, we can not actually disagree with the authors' statement.

The preface seems also to me to be deficient in that, whilst the authors there make a profession of acknowledging the sources from which they have gained information, and of recognising the activity of other laboratories and other workers than those to be met with at St. Andrews, yet in the most marked manner all allusion to the Plymouth Laboratory and the publications of the Marine Biological Association is omitted. After making a eulogistic statement as to the importance of the work done at the St. Andrews Marine Laboratory, followed by a list of those who have worked there, the authors at once proceed to say:

"For many interesting papers connected with the Fisheries we have to thank our fellow-workers in the maritime States of the continent, in America, and the British Colonies."

The suggestion to an uninformed reader is that the only work on these subjects, done elsewhere than "in the maritime States of the continent, in America, and the British Colonies," has been done at St. Andrews. This is very far, indeed, from a truthful suggestion, and is surely due to some oversight on the part of Prof. McIntosh, who has served on the Council of the Marine Biological Association, and is acquainted with the researches carried out on the west coast of Ireland, at Plymouth, in the North Sea, in the Clyde by a host of able investigators remote from his charming little laboratory. Seeing that the authors' book owes a large and important part of its value to the frequent quotations from the *Journal* of the Marine Biological Association, and the work carried on by Mr. Cunningham at the Plymouth Laboratory, and Mr. Holt at Grimsby, it would have been more gracious on their part to have given credit to the Plymouth Laboratory, and the naturalists working in connection with it, when they professed to make acknowledgments to colleagues and predecessors. The work of these investigators, as also of Green, Bateson, Heape and others is made use of, but often without citation of the author's name, and in almost all cases without reference to the original place of publication; so that as a guide to the literature of the subject, the book fails. The index is constructed in a very startling way. One looks up "Cunningham" in order to ascertain how often, and in what terms, his work has been quoted by the authors, and this is what one finds—"Cunningham, J. T., 18, 92, &c." The use of "&c." as a page-reference in an index is altogether new. It does not seem to me to be a real improvement upon the old plan of giving the numbers of the pages to which reference is desired. It is, however, I am sorry to say, indicative of the spirit in which British cotemporary investigators have been treated by Prof. McIntosh and Mr. Masterman.

In a recent review, written by a St. Andrews man, Mr. Cunningham was rebuked for not having referred to Prof. McIntosh and the St. Andrews Laboratory with sufficient frequency in his work on "British Marketable Fishes." It seems that the treatment of the Plymouth Laboratory and *Journal* of the Marine Biological Association and its staff as "&c.," is the retort of St. Andrews. I am sorry, because I have a personal interest in, and regard for both, the Northern and the Southern institution. It is to be hoped that those who have the disposal of fishery appointments at home and abroad will read the productions emanating both from Plymouth and from St. Andrews, so as to be under no illusion as to the non-existence of either. E. RAY LANKESTER.

THE CALCULUS FOR ENGINEERS.

The Calculus for Engineers. By John Perry, F.R.S. Pp. vi + 378. (London and New York: Arnold, 1897.)

HERE is a new departure; a book on the calculus written without any reference to the examination room, solely with the object of teaching the engineer, first that he is already in possession of the fundamental ideas of the calculus, and accustomed to use them, then that these ideas can be easily put into exact mathematical formulæ, and ultimately that the advantages of the formal calculus thus obtained are great indeed, and can be reaped without an enormous amount of previous knowledge.

Prof. Perry does not treat the calculus as something which requires a number of altogether new notions and a great deal of subtle reasoning to be instilled into the mind of the reader. With the instinct of a true teacher, he sets himself to develop notions already in the mind of the learner, and by constant reference to concrete cases leads up to the mathematical ideas of the differential-coefficient and the integral. The former is not defined, as in the ordinary text-books, for any function $y = f(x)$, but the simplest function $y = a + bx$ is considered and plotted out. In fact, Chapter i. begins with the plotting of curves on squared paper, analytical conics or coordinate geometry not being supposed known. It is found that all such equations which have the same value for b have the same *slope*. Hence b is called the slope of the line, and this is denoted by dy/dx. This is followed by exercises on the straight line, familiarising the reader with the notion of slope, and showing how former knowledge of algebra and trigonometry comes in.

Only after this is the differential-coefficient for the simple case treated generally by giving x and y small increments, and therefrom calculating dy/dx. This process of starting with the concrete, and of considering the

abstract question only when all ideas involved have been called into life in the student, is altogether to be praised. Thus a sure foundation is laid.

There follows next the example of a train "going at thirty miles an hour." The notion of velocity (why not call it speed?), and with it that of acceleration, is made mathematically exact. From the law of falling bodies $s = 16{\cdot}1t^2$, the velocity is next deduced. Here the "limiting value" is introduced, and the ordinary process criticised. To quote Prof. Perry:—"Some people have the notion that we are stating something that is only approximately true; it is often because their teacher will say such things as 'reject $16{\cdot}1\delta t$ because it is small,' or 'let dt be an infinitely small amount of time,' and they proceed to divide something by it, showing that although they may reach the age of Methuselah they will never have the common sense of an engineer." It is the art of taking for granted what the "common sense of an engineer"—that is, of any man who has been obliged to think seriously about the things before him, and not only about how to fill so many sheets of paper in a certain time with answers—instinctively knows to be true, and of leaving out of account all the considerations which superfine criticism of minute and exact abstract considerations introduce, which Prof. Perry's book specially emphasises.

After such preliminaries, interspersed with remarks on many things, such as force and weight, we have the equation $y = ax^2$ in the abstract, and from it dy/dx and d^2y/dx^2 with their integrals and applications to uniformly accelerated motion, the energy of elongated springs, to Ohm's law and to transformers, till at last the case

$$y = ax^n$$

is considered. Here the binomial theorem is supposed to be known in its general form. This assumption is one of the few points where a greater simplification might possibly be introduced by giving a few examples where n is 3, $\frac{1}{2}$, -1 or -2, to show that the formulæ are right. I believe that the learner would have greater faith in the result obtained by seeing it verified in special cases, and this is easy. In the integration of x^n the case $n = -1$ is here *assumed* to give $\log x$, the proof being left to Chapter ii.

At the end of Chapter i. (nearly half the book) there are applications in the most varied form of the simple function x^n; and "x^n" forms an appropriate heading to the chapter. Partial differentiation is also introduced as a thing only to be mentioned in order to be understood. We are so much accustomed to have most of the simple functions at our disposal from the beginning, that we do not altogether realise how much can be done with the x^n alone. The applications given by Prof Perry are of a most varied kind, very much more so than those in the ordinary text-books, which almost exclusively treat of problems either purely mathematical or geometrical. The first example relates to a perfect steam engine, then come a study of curves, maxima and minima, strength of rectangular beams, electrical problems, areas, volumes, centres of gravity, moments of inertia, curvature, bending, fluid motion and level surfaces, magnetic field, the two elasticities, laws of thermodynamics and entropy, only to mention some of the headings which strike the eye in turning over the pages. Differential equations, ordinary or other, are introduced without hesitation.

It will be seen from this that the course pursued in this book is very different indeed from that of ordinary text-books. The aim is everywhere to go on slowly with the purely mathematical work, but to make the student feel at each step that he has gained actual and useful knowledge which leads at once to important practical applications; and also to show from the beginning the naturalness of the processes, and to disabuse the beginner of any preconceived idea that the calculus is brimful of difficult and superfine abstractions.

The second chapter contains the compound interest law and the harmonic function; it is headed "e^x and $\sin x$." The exponential theorem is assumed to be known. This is followed by a new series of applications, including Newton's law of cooling, slipping of a belt over a pulley, and so on; and some problems are studied of a body vibrating, introducing both forced vibrations and damping. Mathematical formulation of the problem leads to a linear differential equation of the second order with constant coefficients. The problem of two electric currents with resistance and self- and mutual-induction leads to an equation exactly similar; a solution of one of these problems contains, therefore, that of the other. The mechanical problem, as being more easily followed, is worked out fully; transformers are also dealt with. In fact, both the mechanical and the electrical engineer will get from the study of these first two chapters a great deal of information on the subject he is interested in.

There is a third chapter where more compound functions are considered. It will be remembered that in the first two chapters functions of functions are practically left out, and only the simplest and fundamental functions x^n, e^x and $\sin x$ are introduced. The author now recommends the student to supplement the knowledge so far gained by reading the ordinary treatises on the calculus; but he gives a short outline of the results in his third and last chapter, which has the characteristic heading "Academic Exercises." But even here, in a little more than 100 pages, he goes beyond what is found in most elementary treatises; for he introduces a good many differential equations, and even zonal harmonics and Bessel functions are touched upon. In the middle of the chapter there is a page devoted to Osborne Reynolds' "Theory of Lubrication of Journals," where the essence of Reynolds' complicated investigation is given in a marvellously simple manner.

Of course, from a purely mathematical and academic point of view, it would be easy to find fault, and perhaps to condemn, the whole work. But the book is not meant to be academic; in fact, it is from beginning to end a protest against the academic treatment of mathematics, and as such we welcome it most heartily.

We recommend the book not only to the engineering student and to all who want to learn the calculus, but, indeed, especially to teachers of the subject, who will find many points raised in it to set them thinking, quite apart from the great variety of examples given. We also recommend it most strongly to teachers in the modern or science side of secondary schools. A careful study of the Introduction and the beginning of Chapter i. will give them many hints as to how to make mathematics

attractive to those who are not gifted by nature with the ability to follow abstract reasoning, but who are often very capable of understanding things concrete. They will find also much material for home work.

If the methods here used were more generally introduced into the teaching of mathematics at school, the number of boys declared incapable of learning mathematics would, we feel sure, decrease to an astonishing degree. And indeed the same methods might probably be used in other subjects, and then the science side of secondary schools might lift its head and cease to be the refuge of those who can "neither learn classics nor mathematics." O. HENRICI.

TRAVELS IN THE INTERIOR OF SOUTH AFRICA.

The New Africa: a Journey up the Chobe and down the Okovanga Rivers: a Record of Exploration and Sport. By Aurel Schulz, M.D., and August Hammar, C.E. Pp. xii + 406. (London: Heinemann, 1897.)

THE principal title of this work can hardly be said to be quite applicable to its contents, seeing that the journey it describes was made no less than twelve years ago, before the "scramble for Africa" had reached its full height. In spite, however, of the length of time which has elapsed since the events recorded took place, there is much in Dr. Schulz's pages which well repays perusal. To the class of readers which looks chiefly for an agreeable narrative of sport and adventure, it offers abundant attractions, while those who prefer more solid matter will find scattered through it a considerable amount of information on the country passed through.

Dr. Schulz, who shortly before his journey had qualified in medicine in Berlin, set out from Natal in March 1884, accompanied by Mr. Hammar, on an exploring expedition into the remote interior of South Africa. Proceeding through the Transvaal and Khama's country to the Zambezi, the travellers next ascended the Chobe, its western tributary, to nearly 17° S. lat., and crossed over to the Kubango or Okovanga (this, and not Okavango, is Dr. Schulz's spelling), the principal feeder of Lake Ngami. This river was followed down to the lake, and Khama's country was reached on the return journey by way of the Zuga. A great part of this route led through country rendered classic by the early labours of Livingstone, and since traversed by a host of sportsmen and explorers; but a certain amount of new ground was broken in the region of the Chobe and Okovanga, and as a careful survey was made by Mr. Hammar, some real addition to our knowledge resulted from the journey.

The whole region stretching northwards from Lake Ngami is so level that the rivers form a complex network, the details of which are even now far from completely understood. The confusion is heightened by the fact that several of the streams flow in one direction, or the reverse, according to the time of year. It has long been supposed that the Okovanga sends some of its waters to the Chobe, some finding the connecting channel in the Mababe just west of 24° E. Dr. Schulz claims to have ascertained the existence of another branch of the Okovanga leading to the Chobe. The point of bifurcation was not seen, but an important channel was found to enter the Chobe from the west, and native accounts confirmed Dr. Schulz's suspicion that it came from the Okovanga. The route followed by the expedition led through a barren region of sand-belts, in which the travellers suffered from want of water. The sight of the Okovanga—a fine stream 400 yards broad, of the capabilities of which as a water-way the author expresses a high opinion—was therefore most welcome. It was struck at the town of Debabe or Indala (identical, it appears, with "Andara, or Debabe's town," reached by Green in 1856), and although its course hence to Lake Ngami had previously been explored by that traveller, Andersson and others, Dr. Schulz was able to define, more precisely than they had done, at least the western bank of the series of swamps which mark the course of the river. During this part of the journey the travellers were virtually prisoners, being taken for spies of the Matabele, and conducted under guard to Moremi, chief of the country near the lake, whose people retained no pleasant memory of a Matabele raid to which they had nearly succumbed a few years before. The lives of Dr. Schulz and his party were in some danger for a time, but were saved by the testimony of a child who had been vaccinated by the doctor at Shoshong on the way up.

The book abounds with stories of encounters with the wild animals of South Africa, and gives interesting details illustrating their habits. They were especially plentiful near the Chobe, where their numbers had not yet begun to be thinned by the persecution of sportsmen. One valley is described as having seemed a teeming mass of life, troops of every variety of game appearing to view at the same instant. Dr. Schulz has a good deal to say anent the Mosaros, a desert tribe with which he came in contact, and which he considers a fugitive branch of the Hottentots, distinct from the Bushmen proper, though often called by that name. The book is not provided with an index, but contains a map showing the features of the country along the line of route, with some information on the surface geology. Some of the illustrations give a good idea of the types of country and vegetation common in South Africa.

OUR BOOK SHELF.

Contributions to the Analysis of the Sensations. By Dr. E. Mach, Professor of the History and Theory of Inductive Science in the University of Vienna. Translated by C. M. Williams. Pp. xi + 208. (Chicago: Open Court Publishing Co., 1897.)

PROF. MACH has expressed his approval of this translation of his "Beiträge zur Analyse der Empfindungen." For the most part it has been excellently rendered into English; but occasionally there are sentences that read queerly—*e.g.* "Relatively greater permanency exhibit, first, certain complexes of colours," &c. (p. 2); "Merely its application is not complete" (p. 32); "Different is my opinion with regard to Stricker's views on language" (p. 131); "If the process is over with . . ." (p. 157).

Every one who is interested in psychophysics will welcome an examination of the sensations by a leading physicist, especially when his analysis is so suggestive and his style so delightful as Prof. Mach's. The style is greatly superior to the mode of construction of the book. It would be an exaggeration to say that it is mainly built up of footnotes; but there are three prefaces, two

appendices, addenda, and endless footnotes (with supplementary notes to these). On pp. 34–39 we have some 240 lines of footnotes to 34 lines of text! All this makes the book rather irritating reading, although the notes are valuable and often very amusing. Thus, in a note on the permanence and identification of the ego (p. 4), we read:—

"Not long ago, after a trying railway journey by night, and much fatigued, I got into an omnibus, just as another gentleman appeared at the other end. 'What degenerate pedagogue is that, that has just entered,' thought I. It was myself: opposite me hung a large mirror. The physiognomy of my class, accordingly, was much better known to me than my own."

The author adopts a consistent, monistic conception of Müller's doctrine of the "specific energies," assuming that there are as many physico-chemical neural processes as there are distinguishable qualities of sensation, and regards sensations as *the elements of the world*. The principle of continuity (which has its root in an effort for economy) and the principle of sufficient determination (or differentiation) are employed to investigate the connection between psychologically observable data and the corresponding physical (or physiological) processes. It is throughout assumed that there is a complete parallelism between the psychical and the physical—that there is no real gulf between the two. After a highly interesting discussion of the space-sensations of the eye, the difficult subject of time-sensation is attacked; then sensations of tone. Here we have a criticism of Helmholtz's analysis of the characteristic sensation corresponding to each musical interval, and a new hypothesis (containing a more positive factor in the explanation than the mere absence of beats) is developed at some length.

In spite of its modest dimensions the book is one which no future writer on the subject can afford to neglect. The physicist will find in it much to stimulate inquiry. It offers a refreshing contrast to much that is written on psychology in the originality of its views, of the observations on which they are based, and of the experiments which are devised to test them. *pv.*

Euclid, Books I.–IV. (The University Tutorial Series.) By Rupert Deakin, M.A. Pp. viii + 308. (London: W. B. Clive, Univ. Corres. Coll. Press, 1897).

OF the numerous books which have appeared in the last few years on the propositions of Euclid, each has been put forward as possessing some particular feature of excellence. The writers of these claim, in some cases, that the student cannot have too much detail and explanation given to him in the text, while others aim at a pure cut and dried edition with a great number of accompanying exercises. Each of these types may have their good qualities, for the successful teaching of Euclid is by no means an easy task.

In the book before us the author has, to a great extent, struck a mean between both these lines. His aim has been to lay the proof of each proposition concisely, and yet not too elaborately, before the student, without rendering the proposition too long to cause perplexity and bewilderment. A few easy exercises are added after each proposition, on which the student is advised to exercise his ingenuity.

At the conclusion of each book are inserted a useful series of notes bearing on the propositions, pointing out the chief points of connection and difference between each; then follows a brief but clear summary of the results arrived at in the book under discussion. Teachers might make the students familiar with this summary at an earlier period; and if this be done judiciously, a general survey of the propositions, showing how they are connected with one another, would render the subject more interesting.

Further, some important additional propositions and sets of miscellaneous riders, arranged under different headings, are added, some of which should always be attempted.

The author having had more than twenty years' experience in teaching this subject to both large and small classes, the chief difficulties that are generally met with have received special attention. As a class-book the volume should find much favour.

The Voyages made by the Sieur D. B. to the Islands Dauphiné or Madagascar and Bourbon or Mascarenne in the Years 1669, 1670, 1671 *and* 1672. Translated and edited by Captain Pasfield Oliver, late Royal Artillery. With facsimile maps and illustrations. Pp. xl + 160. (London: David Nutt, 1897.)

THIS little volume might well have been produced by the Hakluyt Society, with the publications of which it is uniform. It is the translation of a rare French book, describing the voyages of one Dubois in the seventeenth century. The translation well reflects the quaintness of the original, although the attempt to imitate the English style and spelling of two centuries since are not always very happy. Captain Oliver has supplied an introduction tracing the history of Dubois, and of the French colonies in the islands of the Indian Ocean during his lifetime; as well as a series of notes on various points mentioned in the text. Apart from the historical interest attached to all early travels the narration of the Sieur D. B. has a certain original value, as he describes from his own observations several of the extinct birds of Réunion, especially the *Solitaire* and *Oiseau bleu*, which were contemporaries of the Dodo of Mauritius, and closely resembled that bird in their habits. These descriptions have long since been fully discussed by ornithologists, both in France and England.

The book is illustrated by a photograph of the surviving giant tortoises which have been removed from the Mascarenes to Mr. Rothschild's park at Tring, and drawings of a number of birds, together with reproductions of modern photographs of the people and products of Madagascar. In view of the renewal of French colonisation in Madagascar, the shrewd observations and far-seeing advice of the old traveller may be worthy of attention. The book well deserved translation, and Captain Oliver is to be congratulated on the excellent manner in which he has brought it out.

Elementarcurs der Zootomie in fünfzehn Vorlesungen. Von Dr. B. Hatschek und Dr. C. J. Cori. Pp. viii + 103. (Jena: Gustav Fischer, 1896.)

THIS little book has been compiled by Prof. Hatschek and Dr. Cori, as a guide to dissection, for the use of elementary students attending lectures in Prag. The fact that no less than ten animals are dealt with in little over one hundred octavo pages sufficiently indicates the scope of the work, which contains simply concise notes of the more important characters of the animals treated, and technical directions for dissecting them. The characters referred to are always such as can be demonstrated by simple dissection, without complicated methods of preparation, and without the use of the compound microscope. It follows from this that the Protozoa are entirely excluded, as are also the Cœlentera.

The names on the title-page are a sufficient guarantee that the information contained in the book is accurate, so far as it goes, and the illustrative drawings are adequate to the purpose in view. No doubt Prof. Hatschek's students will find the book of service to them in their efforts to follow his lectures and laboratory teaching; but there is no reason why English students should desert the works, such as that of Marshall and Hurst, which so many of them at present use.

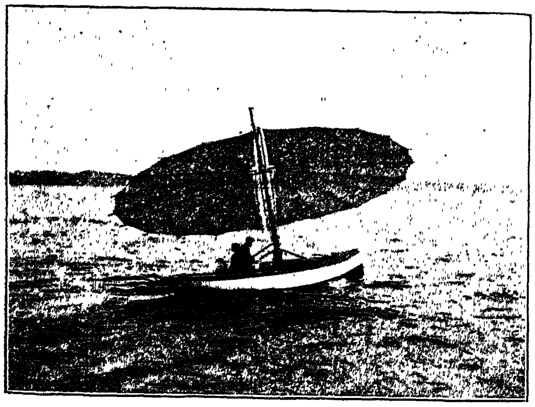
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Cyclone Sail.

I HAVE sent to you, for publication if you think desirable, a photograph of a type of an ideal sail—ideal, in that the wind acting on it has no tendency whatever to incline the boat.

The wind pressure acts practically at right angles to the mean surface of the sail. When the wind is making a large angle



with the sail, the centre of pressure is almost at the centre of the surface, but when the wind strikes the sail at an acute angle, as in all sails or kites, the centre of pressure moves towards the weather edge; but by suitably adjusting the sail, the desirable result of obliterating all heeling movement has been achieved.

In practice this result has been obtained by putting more sail to leeward than to windward of the mast, and also by placing the sail not quite at right angles to the mast, but more raised on the lee side.

The sail is made oval, with the major axis horizontal, so as to be able to carry more sail with a definite height of mast.

The training in a horizontal direction is accomplished by means of a turntable, and the elevating and lowering by two tackles.

There is a balance weight which helps in elevating the mast, and which is just sufficient to balance the dead weight of the sail in a calm, not inclining the boat.

The sail can be set and furled in a minute; it does not close like an umbrella, but each side shuts up like a fan.

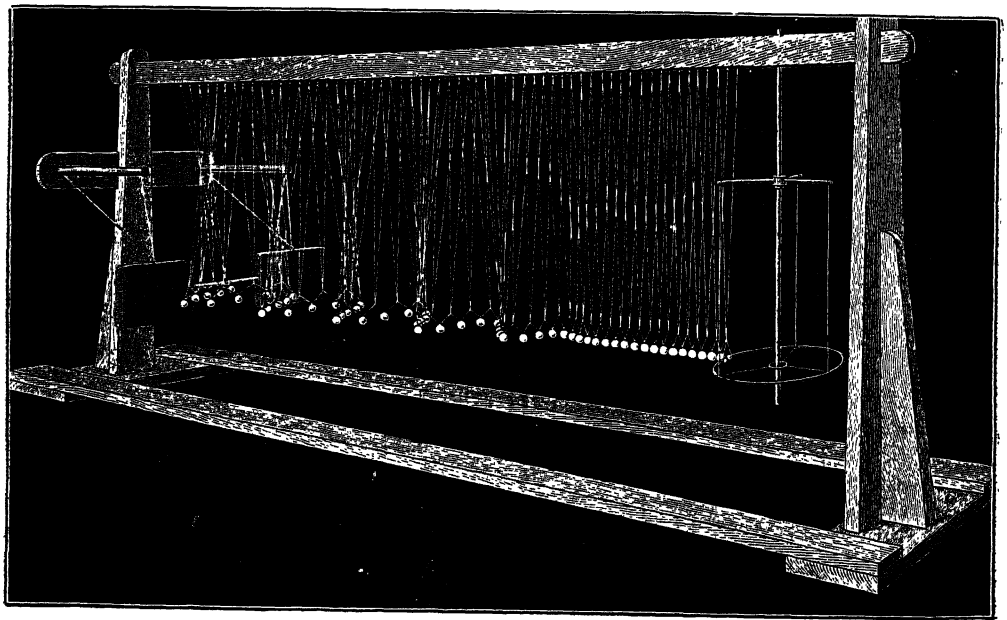
The object of the sail is to be able to sail without inclining the boat, so that the limit of driving force is not governed by the stability of the boat in any way, and also that the boat sailing on an even keel has less resistance than when sailing with a list.

PERCY S. PILCHER.

Artillery Mansions, 75 Victoria Street, S.W.

A Hertz-Wave Model.

IN the spring of the present year I showed, at a meeting of the Physical Society of London, a wave-motion model which I designed to illustrate mechanically the propagation of a transverse wave. As the exhibition of this model on that occasion, and subsequently at the Royal Society and Royal Institution, has elicited a number of inquiries about the apparatus, it is thought that the following brief account of it may be of some interest to lecturers on physics, particularly at a time when the propagation of electric waves through space is occupying much attention. The apparatus, which is depicted in the accompanying cut, is mounted on a strong wooden frame about 2 metres long. At one end (the further in the cut) is the "oscillator," a heavy mass of brass hung by two strong V cords from arms which project parallel to the longer dimension of the frame. This mass, which, for the sake of analogy, is quite unnecessarily shaped to imitate an orthodox electric oscillator, can therefore be set swinging in a transverse direction by a suitable impulse given by hand. At the other end of the frame (the nearer in the cut) is the "resonator," a circle of brass wire hung by a tri-filar suspension. Oscillator and resonator must be adjusted by shortening or lengthening the cords so as to have identical periods of oscillation. The real problem in the construction of the apparatus was to find a mechanical means of transmitting the energy of the oscillator in visible waves to the resonator. The



Mechanical model illustrating propagation of a Hertz wave.

means finally adopted was a series of inter-connected pendulums on a plan somewhat similar to one suggested[1] in 1877 by Prof. Osborne Reynolds. Instead of using springs, however, the requisite inter-connection is obtained by simply suspending the leaden bullets which act as pendulum-bobs by V suspensions

[1] See NATURE, vol. xvi. p. 343.

which overlap, and which, as shown in the cut, are tied together at a point about 4 centimetres above each of the balls. No ball can be laterally displaced without tending to drag its neighbour also: so that a shearing stress is transmitted along the line of balls. As Reynolds showed twenty years ago, the velocity of propagation of the wave-front differs from that of the group of waves owing to the continual dying away of the amplitude of the advancing waves. This effect, due to the inertia of the medium, is of course equivalent to the presence of dispersion in the medium, waves of different frequencies being propagated with slightly different velocities. So far, therefore, as Prof Fitzgerald remarked when the model was exhibited, it illustrates the propagation of the wave in a refracting medium rather than in the ether of space. The waves in the model travel quite slowly; and there is a fascination in watching their progress along the row of balls, until they arrive at the resonator and set it into responsive vibration. There is, of course, no attempt made here to represent the magnetic part of the electromagnetic wave, at right angles to the electrostatic part; the mechanical displacements in the model corresponding to the electrostatic displacements of the Hertzian wave. A row of inter-connected pendulums such as this affords a means of illustrating many points in physics. For many purposes the elaborate system of suspension by strings may be replaced by a continuous fabric. Thus, for example, a piece of netting, hung on hooks from a horizontal rail, and ending below in a short fringe, with leaden beads on the fringe-tips, will also serve to illustrate the propagation of a transverse wave. The structure adopted absolutely refuses to transmit longitudinal disturbances; there being no compressional elasticity between the balls to propagate a longitudinal wave.

SILVANUS P. THOMPSON.

Blackbird's Nest appropriated by a White Wagtail.

I SEE in NATURE of July 15 (p. 248), a letter to the effect that a wagtail had appropriated a blackbird's nest. I beg to state that on June 12 I had the good fortune to find a similar nest at Coburg in Germany. There was a blackbird's nest behind a summer-house in the garden where I was staying, against the wall about 16 feet from the ground. The white wagtail had lined it with moss, hair, and thread, and laid six eggs in it, which, together with the nest, are now in my collection. The gardener and myself both identified the bird.

G. W. DE P. NICHOLSON.

Jesus College, Cambridge, July 27.

THE ROYAL SOCIETY AND ITS HAND-BOOKS.[1]

IT is with most corporations, and especially with an ancient corporation like the Royal Society, a matter of some practical moment to maintain continuity of life and action, and it is always interesting to record that continuity. The "Record of the Royal Society" has this, apparently, as its aim. The "Year-book of the Royal Society," published some few months ago, contains, so the preface to the "Record" informs us, information which is liable to change, and the "Year-book" will accordingly be issued annually; but "the 'Record' contains information, largely historical, such as will not need more than slight additions from time to time," and it is intended therefore to issue new editions of this only at intervals of a few years, as may be found desirable.

Reference to the "Year-book," a copy of which has been sent to us with the "Record," shows that it contains such matters as a table of the meetings for the Session, a list of the Fellows, lists of the Council and Committees, the Statutes, standing orders, and regulations for various occasions, the Society's balance-sheet, schedule of estates and property, and much other matter which is strictly and exclusively of official utility and interest. But the "Record," although it has been officially prepared, as we learn from the preface, by the secretaries, aided by Mr. H. Rix, the late assistant secretary, and is in the main a hand-book of an official sort intended for official purposes, contains, nevertheless, so much that is historical—so much, let us add, that is quaint and antique in flavour—that it has very considerable general interest.

The volume opens with an "Account of the Foundation and Early History of the Royal Society," in which Sprat's, Thompson's and Weld's histories have been used to some extent, but in which much use has also clearly been made of the original MSS. upon which those histories are based. The story has often been told how, about the year 1645, "divers worthy persons, inquisitive into natural philosophy and other parts of human learning," used to meet in London, sometimes at Dr. Goddard's lodgings in Wood Street, sometimes at the "Bull Head" in Cheapside, and, in term-time, at Gresham College; how, about 1648 or 1649, some of this company removed to Oxford, where they founded the Philosophical Society of Oxford, while the Londoners continued their meetings, usually at Gresham College, until the famous gathering of November 28, 1660, when, after Mr. Wren's lecture, the company being withdrawn for "mutuall converse," "amongst other matters that were discoursed of, something was offered about a designe of founding a Colledge for the promoting of Physico-Mathematicall Experimentall Learning." In the present "Account of the Foundation" the steps are traced by which this meeting led to the foundation of the Royal Society, the Charter of Incorporation passing the Great Seal on July 15, 1662, for which grace on the 29th of that month the President, Council, and Fellows went to Whitehall and returned their thanks to his Majesty.

The compilers of this "Account" lay stress upon the fact that in the infancy of the Society one most important feature of a meeting was the performing of experiments before the members. "The experiment was performed for and by itself, and not merely, as now, in illustration of a 'paper communicated.' Papers were read then as now; but the reading of such papers formed only a part, and by no means a great part, of the business of the meeting." An example of one of these early meetings is given, and as it does not appear in Weld's "History," and is a very interesting glimpse of seventeenth century science, it may be worth printing it here in full.

September 10th, 1662.

"Mersennus, his account of the tenacity of cylindricall bodies was read by Mr. Croone, to whome the prosecution of that matter by consulting Galilæo, was referred when the translation of that Italian treatise wherein he handleth of this subject shall bee printed.

"It was order'd, that, at the next meeting Experiments should bee made with wires of severall matters of ye same size, silver, copper, iron, &c., to see what weight will breake them; the curator is Mr. Croone.

"The reading of the french manuscript brought in by Sr. Robert Moray about taking heights and distances by catoptricks was differred till the description of the instrument should come.

"Dr. Goddard made an experiment concerning the force that presseth the aire into lesse dimensions; and it was found, that twelve ounces did contract $\frac{1}{24}$ part of Aire. The quantity of Air is wanting.

"My Lord Brouncker was desired to send his Glass to Dr. Goddard, to make further experiments about the force of pressing aire into less dimensions.

"Dr. Wren was put in mind to prosecute Mr. Rook's observations concerning the motions of the satellites of Jupiter.

"Dr. Charleton read an Essay of his, concerning the velocity of sounds, direct and reflexe, and was desired to prosecute this matter; and to bring his discourse again next day to bee enter'd.

"Dr. Goddard made the Experiment to show how much aire a man's lungs may hold, by sucking up water

[1] "The Record of the Royal Society of London," 1897, No. 1. "Year-book of the Royal Society of London," 1896–97, No. 1.

into a separating glasse after the lungs have been well emptied of Aire. Severall persons of the Society trying it, some sucked up in one suction about three pintes of water, one six, another eight pintes and three quarters &c. Here was observed the variety of whistles or tones, which ye water made at the severall hights, in falling out of the glasse again.

"Mr. Evelyn's experiment was brought in of Animal engrafting, and in particular of making a Cock spur grow on a Cock's head.

"It was discoursed whether there bee any such thing as sexes in trees and other plants; some instances were brought of Palme trees, plum trees, hollies, Ash trees, Quinces, pionies, &c., wherein a difference was said to be found, either in their bearing of fruit or in their hardnesse and softness, or in their medicall operations: some said that the difference which is in trees as to fertility or sterility may be made by ingrafting.

"Mention was made by Sr. Rob. Moray of a French Gentleman who having been some while since in England, and present at a meeting of the Society, discoursed that the nature of all trees was to run altogether to wood, which was changed by a certaine way of cutting them, whereby they were made against their nature to beare fruit, and that according as this cutting was done with more, or lesse, skill the more or less fruitfull the tree would bee.

"A proposition was offered by Sr. Robert Moray about the planting of Timber in England and the preserving of what is now growing.

"Mr. Boyle shew'd a Puppey in a certaine liquour, wherein it had been preserved during all the hott months of the Summer, though in a broken and unsealed glasse.

"Sir James Shaen proposed a Candidate by Sr. Rob. Moray."

The experiments were afterwards carried out by "Curators of Experiments," and some account is here added of this office, which was first held by Robert Hooke.

The whole of this condensed history extends to only eighteen pages. It is illustrated by two plates containing portraits, not indeed of the first six Presidents, for the portrait of Sir Cyril Wyche is wanting, but of the Presidents from Lord Brouncker to the Earl of Carbery, with this exception. If these can be continued in future issues, and especially if some likeness of Wyche, and of any others which may be at present missing can be discovered and reproduced, it will make a valuable series. Portraits of Henry Oldenburg, the first Secretary, and of Robert Boyle, one of the earliest Fellows, are also given.

This introductory history of the Society's birth and youth is followed by other matters of more or less historical interest; the text of the Charters, a history of the Statutes, a list of the Benefactors of the Society from "Carolus Secundus, Fundator," downwards; a history of the Trusts, and so forth. We are also furnished with accounts of other institutions which are controlled by, or more or less closely connected with, the Royal Society, from the Kew Observatory, which is governed by a Committee appointed by the Royal Society's Council, to "The Physick Garden" of Chelsea, in which the Society has, as we read, "only a reversionary interest."

With respect to the latter institution, its connection with the Royal Society at its first foundation was closer than at present, and was rather curious. The garden, now more generally known as "The Botanic Garden, Chelsea," was founded by Sir Hans Sloane in 1722, by a deed which enacted "That the garden should at all times hereafter be continued as a Physick Garden" by the Society of Apothecaries, which Society should yearly present to the Royal Society "fifty specimens or samples of distinct plants, well dried and preserved, and which grew in the said garden the same year, together with their respective names or reputed names, and so as the specimens or samples of such plants be different, or specifically distinct, and no one offered twice, until the complete number of two thousand plants have been delivered." This tale of two thousand was completed, we learn, in the year 1762.

The "Record" contains, furthermore, statements of the origin and progress of various branches of work which the Society is still carrying on—the Government Grant for Scientific Investigations, which finds its spring and source in a letter addressed in the year 1849 by Lord John Russell to the late Earl of Rosse; the Society's publications, comprising, besides monographs, the *Philosophical Transactions*—a noble series of volumes extending over more than two centuries—the *Proceedings*, and the *Catalogue of Scientific Papers*. The last-named arduous undertaking is, indeed, one of the most important branches of work at present being carried on by the Society. Some account of it, reprinted in part in the volume under review, appeared in our pages some time since (NATURE, vol. xlv. p. 338). Then there is the library, the pedigree of which, so far as concerns some of the classical and antiquarian literature, is traced through the Arundel Library (presented to the Society in its earliest days by Henry Howard, afterwards sixth Duke of Norfolk) to Bilibald Pirckheimer, the friend of Albrecht Dürer, and from him to Matthias Corvinus, King of Hungary.

Sundry lists are added—a list of instruments and relics, a list of portraits, a list of medals, of presidents, treasurers and secretaries of the Society, and of persons to whom the Society's medals have been awarded, all of which, though arranged, as we have said, in official form, and obviously intended for official purposes, contain matter which the future historian of science cannot fail to find of great importance. Here, for instance, we learn that the Society has in its possession many relics of Sir Isaac Newton, including his telescope, the mask from the cast of his face taken after death, and the MS. of the Principia from which the first edition was printed. Here we learn that the Society treasures Boyle's air-pump, Petty's double-bottomed boat, Huyghens's aerial telescope, Priestley's electrical machine, and the original Davy's safety lamp; and here, under the names of the successive Presidents, we find biographical notes which should be of value. Weld's "History of the Society" carries us down only to the year 1830, and it is but an imperfect compilation at the best. When the story is continued by some later hand—as continued it certainly ought to be—the prospective series, of which this "Record" forms the first volume, should considerably lighten the historian's task.

X.

SOARING FLIGHT.

SOME time ago we referred, in an article on "Soaring Machines" (NATURE, vol. liii. p. 301; see also p. 365), to the experiments which Mr. Percy S. Pilcher had commenced to carry out in this country on the lines laid down by the late Herr Lilienthal in Germany. Since that time Mr. Pilcher has gained considerable experience both in the making and handling of these aëro-planes, and quite recently he was able to make a successful ascent and descent before numerous spectators, under conditions which were not very favourable. An idea of the general shape of the machine he used may be gathered from the six accompanying illustrations, which are enlargements of six out of the numerous pictures taken during flight by means of the cinematograph. The machine itself weighed fifty pounds, the framework being made of bamboo; the latter could be easily folded up, but when spread out and carried the sail material covered

a surface area of 170 square feet. The tail, which can be seen at the back of the framework, consisted of two small surfaces placed horizontally and vertically; this had no means of movement in the lateral direction, but was capable of movement in the vertical direction *above* its horizontal position, about a fixed point in the framework. Such an arrangement as this was found to work best, as it eliminated to a great extent the liability of taking "headers." It plays, therefore, a rather important *rôle* in the machine.

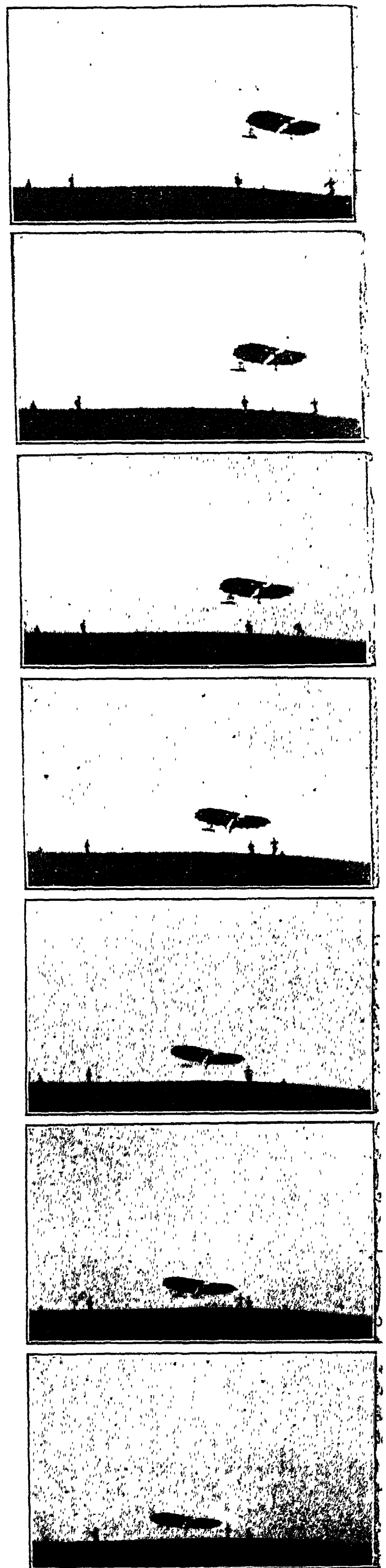
When in a position for flight the arms of the operator, as far as the elbows, are placed in a stiff sleeve fitted to each side of the inner portion of the framework, and each hand grasps a small upright peg fixed also to the same support; by this means a firm grip of the apparatus when off the ground may be obtained. It will thus be seen that when in flight the whole weight of the operator is on the two elbows; and it may be further stated that, to prevent the whole arm from becoming straight through any emergency requiring the movement of the body backwards, two fixed pads, supported on uprights attached to the framework, are positioned behind the shoulder-blades.

At the time of the flight (here illustrated) the wind was so light and variable in direction, that an ascent from even the elevated position taken up was almost impossible. Means, however, were at hand by which one end of a thin fishing-line, 600 yards long, could be attached to the machine, while the other end passed through two blocks placed close together on the ground at a distance from the aero-plane of about 550 yards. These blocks were so arranged that a movement of the aerial machine in the horizontal direction corresponded to a fifth of the movement of the boys pulling the line.

The start was made at a given signal, the line being pulled by three boys, and Mr. Pilcher gradually left the ground, and soared gracefully into the air, attaining a maximum height of about 70 feet. After covering a distance of about 180 yards the line suddenly parted, a knot having slipped. The only apparent difference this made was that the operator began now to slowly descend, his motion in the horizontal direction being somewhat reduced. A safe and graceful landing was made at a distance of 250 yards from the starting-point. The photographs illustrate that part of the flight previous to the attainment of the greatest height. It may be mentioned that the tension of the line amounted only to about 20 lb., so that only quite a weak pull was required to give the necessary lifting power: the trial indicated, however, that if the machine had been fitted with a small engine or motor, to give this amount of thrust by means of a screw or otherwise, perhaps an equal or further distance would have been covered.

Mr. Pilcher now proposes to employ, as soon as possible, a small and light engine indicating about four horse-power, this being considerably more than sufficient for flights of moderate length. It is, however, thought advisable to have rather too much than too little power to commence with, as a factor of safety. With this improvement it is hoped that further distances will be covered, and a nearer approximation to a flying machine will be attained.

In these attempts it must not be forgotten that there is always a certain amount of danger attached until we possess sufficient knowledge to guard against it. Experience, then, has to be dearly bought, and it requires no small amount of pluck and determination to trust one's self to these aerial crafts. Further, the serious experimenter must have both time and money at his disposal to successfully combat the many unforeseen difficulties that arise, and to carry out the alterations that must be made, to say nothing of the fact that each trial may result in the apparatus being completely or partially damaged. Those pursuing the inquiry must, therefore, have either considerable private means, or be supported



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financially by those who take an interest in this big problem. The subject, we know, is still in its infancy; but it is hoped that those who wish that this country should take some part in this problem of aerial navigation should bear a hand and support those who are w ling to carry out the necessary experiments.

WILLIAM J. S. LOCKYER.

THE CALCUTTA EARTHQUAKE.

IN a previous number of NATURE (June 24, vol. lvi. p. 174), Mr. T. Heath gave an account, *re* the Indian earthquake, of the oscillations set up in the bifilar pendulum of the Edinburgh Observatory between the times June 11, 23h. 18m., and June 12, 0h. 33m. The reproduction of the photographic record accompanying the letter did not, however, show any of the minor details of the effect produced. We have received a communication from Prof. P. Blaserna, in which these details are clearly depicted on the records obtained with the instruments erected at the Royal Geodetic Observatory of Rocca di Papa (Rome). The curves here shown illustrate the movements of the N.-S. (Fig. 1), and the E.-W. (Fig. 2) components of a horizontal pendulum, and show better than any description the increase and decrease in the length of swing of the pendulum at the times (intervals of ten minutes) indicated by the short arrows. We may mention that a second set of curves, made with another quite independent instrument (seismometograph with a vertical pendulum carrying a mass of 200 kilograms), recorded nearly similar disturbances at the same times. This latter instrument is also situated at Rocca di Papa, and directed by Dr. A. Cancani. The above curves, besides indicating the effect produced by the shocks caused by the Calcutta earthquake, show how very efficient the Roman instruments are for recording the minute details of the earth's movements.

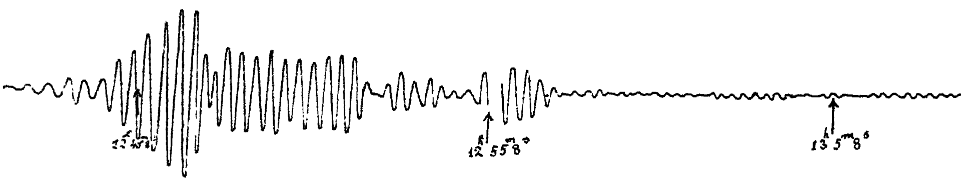

FIG. 1.—June 12, N.-S. component.

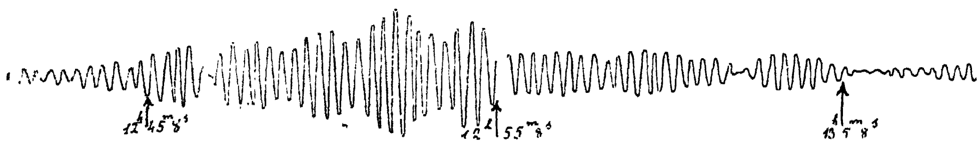

FIG. 2.—June 12, E.-W. component.

NOTES.

THERE seems some probability that Jamaica may be selected by the American Commission for the site of the proposed Tropical Botanical Station. Profs. MacDougal and Campbell have restricted themselves in their tour of investigation to that island, and have expressed themselves as well satisfied with the conditions of the rich and varied vegetation there found. The Director of the Botanical Department, Mr. W. Fawcett, is prepared to render every assistance in the furtherance of the object.

THE Scientific Society of Argentina is organising a Congreso Cientifico Latino Americano, to be held at Buenos Ayres in April next, in commemoration of the twenty-fifth anniversary of its foundation. The Congress will be under the patronage of the President of the Argentine Republic and the Ministers of Justice, Foreign Affairs, and Public Instruction. There will be seven sections, dealing respectively with exact sciences (pure and applied mathematics, astronomy, geodesy and topography), engineering, physics and chemistry, natural science, medical sciences (including hygiene and climatology), anthropology and sociology.

M. HAUTEFEUILLE, member of the Section of Mineralogy of the Paris Academy of Sciences, has been promoted to the rank of Officer of the Legion of Honour. M. J. Vinot has been made a Chevalier of the Legion of Honour.

PROF. WM. LIBBEY, JUN., of Princeton, has succeeded in making the ascent of the Mesa Encantada, near Albuquerque, New Mexico, by the use of a cannon and life-line. The line was thrown over the *mesa*, and successively larger cords were attached, till after two days' labour a rope of sufficient strength to raise a man in a chair was in position. No archæological remains were discovered, except rocks piled up as if man had perhaps piled them. Tradition ran that the *mesa* had been inhabited until the means of access were swept away four centuries ago.

THE Paris correspondent of the *Times* states that Dr. Robert Wurtz, professor at the Paris School of Medicine, has been chosen, as one of the leading French bacteriologists, for a mission in Abyssinia. He is to start for Jibutil and to go on direct to Adis Abeba, where, after having organised a department of vaccination, he will study the rinderpest and similar infectious maladies which chronically ravage Menelik's empire.

THE death is announced of Dr. W. Petzold, known by his contributions to geographical and astronomical literature.

WE regret to announce the death of Prof. Victor Meyer, the distinguished professor of chemistry in the University of Heidelberg.

THE Government of Victoria is offering a bonus of 1000*l*. for the invention of an efficient and not too costly method of ventilating mines.

THE Belgian Chamber of Representatives has voted an additional grant of sixty thousand francs in aid of M. de Gerlache's expedition to the South Pole.

THE statue of Charles Darwin, erected in his native town of Shrewsbury and in front of the school which for nine years he attended, was unveiled on Tuesday. The statue, which is of bronze, is the gift of the Shropshire Horticultural Society, and cost 1000 guineas.

THE thirty-fourth annual conference of the British Pharmaceutical Association was opened at Glasgow on Tuesday, under the presidency of Dr. Symes, of Liverpool.

OWING to the advance of areas of low barometric pressure over our islands from the Atlantic since the beginning of the month, the weather, which for a considerable period had been very fine, under the influence of an anti-cyclonic system, became very unsettled, and thunderstorms were experienced in nearly all parts. The reports issued by the Meteorological Office show that some high temperatures were registered: on the 4th and 5th, readings of 90° (in shade) were recorded in the east of England, and 88° in the southern parts of the country. On the latter day rain fell heavily over the northern parts; at St. Helens (in Lancashire) 2·28 inches were measured in three-quarters of an hour. The disturbance on Sunday, the 8th inst., caused further thunderstorms and rainfall in the southern parts of the country, 0·8 inch being measured at Oxford and 0·7 inch in London. This is the heaviest fall in London in one day since January 8 last.

ABOUT this time every year the Société Industrielle de Mulhouse issues a "Programme des Prix" to be awarded in the following year. The list of prizes to be awarded in 1898 has just been received, and it contains no less than 144 prize-subjects. No useful purpose would be served by describing all these subjects, but attention may profitably be called to the following among them:—5000 francs for discoveries or inventions which in the preceding ten years have been most useful to industries in the district of the Upper Rhine; a medal and 1000 francs for the best memoir upon the combing of textile materials; a medal and 1000 francs for the production of a substance to replace the albumen of eggs in making painters' canvas; 1000 francs for an albumen to replace the white of eggs in all industrial uses of the same; a silver medal and 500 francs for the best memoir on a new and advantageous method of constructing factory buildings; a silver medal and 500 francs for new theoretical and practical researches on the movement of steam in pipes; a silver medal and 500 francs for the invention and application of a registering pyrometer intended to show the temperature of the gaseous products of the combustion of coal in steam engines; a medal and 500 or 1000 francs (according to the importance of the work) for a memoir on electromotive force in mono- or poly-phase alternators. The remaining prizes are mostly medals, which will be awarded for advances in the industrial arts and for long service. All the prizes are open to every one except the members of the committees of the Société industrielle and the Council of administration. Competing memoirs must be sent, before February 15, 1898, to the President of the Society. A copy of the Programme des Prix will be sent upon application to the Secretary.

JERSEY offers many opportunities for workers in the wide field of natural science. The Jersey Natural Science Association, which was founded on Thursday last, ought therefore, by organising the studies of the naturalists of the Island, to be of real assistance in scientific progress. The Island presents many important sections for the student of geology and mineralogy, while the work already done, in a quiet way by some of its inhabitants, indicates how a properly organised body of workers can advance natural knowledge. The new association has been instituted for the purpose of carrying on scientific research and cultivating the spirit of investigation by: (a) original papers or communications; (b) field work and excursions; (c) the delivery of popular scientific lectures when such can be arranged; (d) the formation of a museum and lending library for the use of members. The patron of the Association is Major-General E. Hopton, C.B. (the Lieut.-Governor of Jersey), and the officers are:—President, Dr. A. C. Godfray; Vice-Presidents, Mr. R. R. Lemprière (Viscount of Jersey), and Mr. H. E. Le V. dit Durell (Connétable of St. Helier); Hon. Treasurer, Mr. P. Asplet; Hon. Secretary and Librarian, Mr. C. A. Snazelle.

THE death of Prof. Alfred Marshall Mayer, professor of physics in the Stevens Institute of Technology, Hoboken, N.J., on July 13, has already been announced in these columns. From an obituary notice in the *American Journal of Science* we extract the following particulars of Prof. Mayer's life and scientific work:—Prof. Mayer was born in Baltimore, Md., November 13, 1836, and received his education at St. Mary's College, Baltimore. After leaving this institution, in 1852, he spent two years in the office and workshop of a mechanical engineer, where he acquired a knowledge of mechanical processes and the use of tools, for which he had a natural aptitude. This was followed by a course of two years in a chemical laboratory, where he obtained a thorough knowledge of analytical chemistry. In 1856 he was made professor of physics and chemistry in the University of Maryland, and three years later he entered upon a similar position in Westminster College, Mo., where he remained two years. In 1863 he went abroad, and entered the University of Paris, where he spent two years in the study of physics, mathematics and physiology. While in Paris he was a pupil of the distinguished physicist Regnault. After his return to America he occupied a chair in Pennsylvania College, Gettysburg, and later in Lehigh University, Bethlehem, where he was in charge of the department of astronomy, and superintended the erection of an observatory. In 1869, an expedition was sent by the U.S. Nautical Almanac Office to Burlington, Iowa, to observe the eclipse of August 7. Prof. Mayer was placed in charge of the expedition, and obtained a large number of successful photographs. In 1871 he was called to the professorship of physics in the Stevens Institute of Technology, which position he held until the close of his life. Prof. Mayer was an enthusiastic and active investigator, and a prolific writer upon scientific subjects. He made numerous contributions to various journals, cyclopædias, and other scientific publications, but the memoirs in which he embodied the results of his own researches were chiefly published in the *American Journal of Science*. His papers published in that journal, since 1870, number forty-seven titles, covering nearly four hundred closely printed pages, not counting various notes and minor contributions. While embracing a great variety of topics in physics, his studies were more actively pursued in the departments of electricity and electro-magnetic phenomena, in optics, especially photometry and colour-contrasts, but more particularly in acoustics, which was a favourite field of research, in which his discoveries gave him the prominence and authority of a specialist. His acoustical researches form a connected series of papers, which together amount to nearly one-half the total volume of his contributions. Prof. Mayer received the degree of Ph.D. from the Pennsylvania College in 1866. In 1872 he was elected a member of the National Academy of Sciences, and was connected with many other scientific societies. He possessed great ingenuity and skill in construction, and a remarkable degree of delicacy and precision as an experimenter, which enabled him to obtain results that will have a high and permanent value in science.

A SLIGHT earthquake was felt at Hereford on Monday morning, July 19, between half-past three and four. Mr. E. Armitage, writing from Dadnor, Ross, Herefordshire, says that the disturbance was felt at 3.50 a.m. He adds: "The rumbling sound was accompanied by a distinct shock of momentary duration, sufficiently strong to awaken sleepers. The direction of the seismic wave was from east to west."

MR. R. J. USSHER records in the *Irish Naturalist* the discovery of bones of the Great Auk in kitchen-middens on the coast of County Waterford. The bones have been determined as belonging to the Great Auk by Prof. Newton and Dr. Gadow: with them were found bones or horns of ox, goat,

horse, pig, red deer, and domestic fowl; also an abundance of shells of oysters, cockles, mussels and limpets, with many pot-boilers or burned stones. It is pointed out that bones of this extinct bird have been found in the kitchen-middens of Denmark, in one or two places in Scotland, in Durham, and on the North American coast. More recently, they have been found on the County Antrim coast. Mr. Ussher's find corroborates this discovery, and shows that the range of the Great Auk extended in Ireland nearly as far south as 52° N. latitude.

A NUMBER of interesting navigational instruments were exhibited at the Fishmongers' Hall last week. The exhibition was organised by a sub-committee of the Shipmasters' Society, with Captain D. Wilson-Barker as chairman, and was principally intended to illustrate the progress that has been made in the art of navigation during Her Majesty's reign. Altogether there were about 200 exhibits, some of which are of historic importance. Included among these was a sextant, by Bird, said to have been used by Captain Cook. There was a well selected number of charts and navigation books, among the exhibitors in this section being Admiral Sir W. J. L. Wharton, F.R.S. The Meteorological Society lent several meteorological instruments such as are in use at sea, while in contrast with the quadrants, sextants, compasses, &c., which did duty in 1837, instruments of a more modern date were on view, comprising some of Lord Kelvin's inventions, such as the deflector for adjusting the compass without swinging the ship, the vertical force instrument, and the sounding machine. Sections were also devoted to ships' models and pictures, ancient charts and books, and ancient instruments.

THE Pilot Chart of the North Pacific Ocean for August, published by the American Hydrographic Office, contains a large amount of information useful to navigators. In addition to the usual arrows showing the prevalent direction and force of the wind and the drift of the currents, there is a forecast of the wind and weather which may be expected during the month, and also a chart showing the mean atmospheric conditions at Greenwich mean noon, any large variation from which may indicate a coming gale. As this is the season of maximum frequency of typhoons, as shown by the table compiled by Dr. Doberck, of the Hongkong Observatory for the thirteen years 1883–96, a special notice of these storms is given. Attention is drawn to the fact that the typhoon of the Western Pacific is in many respects the counterpart of the West Indian hurricane in the Atlantic. Both classes of storms have their origin in the vicinity of tropical groups of islands, and, under similar barometric conditions, both undergo the same slow development, and exhibit the same tendency to recurve upon reaching the northern limit of the north-east trades.

SOME facts of interest in connection with gold-washing on the Saskatchewan River are stated in the Report of the Geological Survey of Canada for 1895 (vol. viii. new series) just issued. The principal paying bars are found along the river within a distance of about sixty miles above and a similar distance below Edmonton. It is pointed out, however, that the occurrence of gold is not limited to the North Saskatchewan, the metal being found, in greater or less abundance, on portions of the courses of all the rivers east of the Rocky Mountains from the forty-ninth parallel northward.

THE auriferous character of the rocks of the Huronian system in Canada has been established by mining operations of recent years. The economic importance and generally metalliferous character of Huronian rocks was recognised by Sir William Logan in reports of the Canadian survey made nearly forty years ago. Referring to this, Dr. Dawson says in the latest report: "It is gratifying to observe that the practical miner is now beginning to appreciate the value of a large amount of geological work carried out in the country to the north of the Great Lakes, which, a few years ago, it might have appeared difficult to justify in the light of any economic results up to that time achieved. There can now be very little doubt that every square mile of the Huronian formation of Canada will sooner or later become an object of interest to the prospector, and that industries of considerable importance may yet be planted upon this formation in districts far to the north, or for other reasons at present regarded as barren and useless." The conclusions which Dr. Dawson arrived at as to the richness of the Yukon district, after his exploration of it in 1887, have lately been so strikingly established by the discovery of large quantities of gold on the Klondyke River, that his suggestions as to the commercial value of Huronian rocks will probably receive the attention of the mining world.

IN the *Bulletin de l'Académie des Sciences de Cracovie*, Dr. L. Natanson gives a kinetic theory of the equations of vortex-motion of fluids. This investigation is of special interest, inasmuch as it takes account of a certain molecular property to which the name "constraint of perturbations" (*coercition des perturbations*) has been applied. As long ago as 1845, the connection of the laws of vortex-motion with the principle of moments was pointed out by Sir G. G. Stokes. Dr. Natanson's paper may be said, in a certain sense, to be a development of this idea, in that he shows how the equations of Helmholtz and Nanson can be verified by supposing the so called "forces of constraint" to satisfy the equations of angular momentum.

A NEW cable recorder, invented by M. Ader, is described in *La Nature* of July 24. It consists essentially of a fine wire stretched vertically in a magnetic field created by a strong horizontal electro-magnet, the poles of which surround the wire. The currents from the cable traverse the wire, which moves to the right or left—that is, towards the north or the south pole of the electro-magnet—according to their direction. A shadow of the wire is projected across a slit, behind which a band of photographic paper travels. A black spot thus falls upon the paper, and as the wire moves to the right or left the movements are traced upon the photographic paper by the shadow of the spot, the result being a record similar to that given by the syphon recorder. The paper is developed automatically in three baths contained in a small dark chamber, and the signals are shown in white upon a black ground. As to the speed obtained, 350 letters a minute, that is, about seventy words, have been recorded through the cable between Marseilles and Algiers, and 150 letters per minute have been recorded upon the Brest-New York cable, the transmitter being at St. Pierre-Miquelon, and the receiver at Brest.

IN July of last year, Prof. Eschenhagen, of Potsdam, presented to the Berlin Academy a preliminary note on certain small variations of the earth's magnetism, which he had then detected for the first time. The apparatus then used consisted of a unifilar magnetometer, in which the magnet, a small steel mirror, was made to lie perpendicularly to the magnetic meridian by the torsion of the suspending quartz fibre. An account of further researches on the same subject is now given in the *Berliner Sitzungsberichte*. The most important oscillations have a period of about thirty seconds, and are observed chiefly between 6 a.m. and 6 p.m., *i.e.* roughly speaking, when the sun is above the horizon. Since October last waves of shorter period, lasting about twelve to fifteen seconds, have only been observed on two days, viz. November 7, 1896 and February 4, 1897; but these were of only half the amplitude of the normal waves. On several occasions, however, groups of waves were observed which could readily be accounted for by interference, as they closely resembled beats in acoustics. From

observations made at Potsdam and Wilhelmshaven, it seems probable that the same disturbances take place almost simultaneously over a considerable area, but further observations are required in confirmation of this point. The cause of the phenomenon is uncertain, but Prof. Eschenhagen inclines to the view that it is of atmospheric origin, in conformity with Schuster and Von Bezold's theories of the diurnal variations. The author finally suggests a convenient means of detecting these rapid fluctuations by observing the induced currents in a sufficiently large coil, a method which has the advantage of practically eliminating disturbances of long period.

THE first number of a new quarterly botanical journal has made its appearance, with the title *Bollettino del Reale Orto Botanico di Palermo*, under the editorship of Prof. Borzì, intended as a record of the work done in the Botanical Garden and Botanical Institute at Palermo. Among the articles in the number already published are: A new genus of Cactaceæ, *Myrtillocactus*, by M. Console; Experiments on acclimatisation; and some new and critical species of Liliaceæ, by Prof. Borzì; species of *Agave* described within the last ten years, by A. Terraciano.

THE most recent of the series of "Hand-lists" of plants in cultivation in 1897 at the Royal Gardens, Kew, comprises the tender Monocotyledones (excluding the Orchids). The preface contains a general description of the collection, under the heads of the different natural orders, Scitamineæ, Bromeliaceæ, Palmæ, Pandanaceæ, Aroideæ, &c. It will probably surprise many who are unacquainted with the extent of our national collection to hear that there are now under cultivation at Kew upwards of 400 species of Palm, and 360 Aroids. The collection of Palms is probably the largest in the world.

THE question as to the age of the dicotyledons is one of great importance, and any new facts which may be brought to light are therefore looked upon with great interest. In the *Proceedings* of the Linnean Society of New South Wales (for March 31), the president, Mr. Henry Deane, in his address to the Society, makes an interesting reference to the earliest dicotyledons in the northern hemisphere and in Australia. It may be mentioned, however, that up to 1888 the oldest known dicotyledon was one from the Middle Cretaceous of Greenland, described by Heer under the name of *Populus primæva*. In the same year Prof. Fontaine found in some of the Lower Potomac series—in what was supposed to be Jurassic—some portions of leaves resembling dicotyledons, but not easily distinguishable from the lower groups, ferns, cycads, and other gymnosperms. Further discoveries of known flora have been found in Potomac formation, and an unbroken series from the oldest to the newest beds have been brought to light, and in the latter the dicotyledonous element largely predominated.

As regards their occurrence in old beds in Australia, Mr. Deane says:—"The fossils of the Oxley beds are well developed dicotyledons, quite equal in development to those found in the Upper Cretaceous in Europe and North America. The Oxley beds are near the top of the Ipswich Coal Measures, which are supposed to be at latest Jurassic in age. The difficulty of reconciling the fact of the full development of the dicotyledonous type in Australia with the very archaic rudimentary types of the same age in North America, which are mentioned by Lester Ward, struck me very forcibly, and as in the western parts of the colony it had been shown that the Lower Cretaceous beds lie conformably, or at an angle not distinguishable, upon the beds below them." Mr. R. L. Jack's opinion of these beds is that he believes them "to be below the thick Murphy's Creek Sandstone and the Clifton Coals and Shales . . ." and he cannot see his way to put "the Oxley beds on a higher horizon than the rest of the Ipswich formation." Mr. Deane concludes that the above views "point undoubtedly to the conclusion that at an age when European and American dicotyledons exhibited a rudimentary or transition character, the southern hemisphere already possessed types of high development. Before this becomes an accepted fact, it is needless to say that some further corroboration of the conclusions as to the correspondence in age of the so-called Jurassic beds of Australia and those of the northern hemisphere should be sought."

THE Annual Report, just received, of the Manchester Microscopical Society for 1896 furnishes evidence of useful work done in the northern capital. There are good papers in several departments of botany and zoology, as well as one on "The New Light and the New Photography."

The Photogram for the present month will be found to contain many short articles of interest, and several notes of useful hints. With regard to kinetography we read, "the greatest kinetographic success of the Jubilee was scored by the *Bradford Argus* and by their kinetographers, R. J. Appleton and Co. Both good management and good luck seem to have befriended them, for the eclipsing parasol of Her Majesty the Queen was raised just as she passed their stand, and a happy smile (duly recorded) passed over the royal countenance. A van specially fitted for developing, printing, &c., was attached to one of the trains to Bradford, and by midnight on the 22nd the view of the whole procession was projected on to a screen facing Forster Square, which was thronged by thousands of people." Have many of our readers used the Ilford Special Rapid Plates? These are very quick plates indeed, and require only about a fourth of the time of exposure of the ordinary plates. If a person is used to slow plates, these rapid ones must be handled with care. The tendency should be to try to rather under- than over-expose them; the developer should not be too strong at first, and should be kept well under control. They should also during development be placed in the dark. Accompanying a few words on "A Notable Photographer," are two excellent reproductions from negatives taken by Mr. H. Walter Barnett.

THE following are among the articles, and other publications, which have come under our notice during the past few days:—"The San José Scale and its Nearest Allies," by Prof. T. D. A. Cockerell, published by the U.S. Department of Agriculture (Division of Entomology), Technical Series, No. 6. The information given in this bulletin will enable all entomologists, and every one else who has access to a compound microscope, to distinguish definitely between the San José scale and its closest allies.—The New York *Nation* is publishing a series of articles upon the Schools of Archæology at Athens, by J. R. S. Sterrett.—The second part of a valuable report on the valley regions of Alabama (Palæozoic Strata), by Henry McCalley, has been published by the Geological Survey of that State, under the direction of Dr. E. A. Smith. Part i. dealt with the Tennessee Valley region, and Part ii. is concerned with the resources of the Coosa Valley region. The report is illustrated with a number of fine reproductions of photographs, and contains a mass of information upon the physical features, geology, natural resources, soils, agricultural features, timber, water-power, climate, health, rainfall and drainage of Alabama.—The metamorphosis of a dragon-fly is described by the Rev. A. East, in the August number of *Knowledge*, and is illustrated with reproductions of six striking photographs of different stages of emergence of the insect from the nymph skin.—The official report of the International Meteorological Conference, held at Paris last September, and reported in NATURE at the time (vol. liv. p. 624), has just been published by authority of the Meteorological Council. Among the subjects and authors

of papers appended to the report are:—"The Centres of Action of the Atmosphere," by Prof. H. H. Hildebrandsson; "Simultaneous Magnetic Observations," by Dr. Eschenhagen; "The Registration of Atmospheric Electricity," by M. A. Chauveau; "The Reduction of Anemometrical Data," by Dr. Sprung; "The Employment of the Hypsometer to determine the Pressure of the Air and the Gravity Correction for Mercurial Barometers," by Prof. Mohn; "International Co-operation in prosecuting work and publishing results in Ocean Meteorology," by Dr. Neumayer.

THE additions to the Zoological Society's Gardens during the past week include a —— Genet (*Genetta* ——) from South-east Brazil, presented by Mr. J. E. Matcham; a Guinea Baboon (*Cynocephalus sphinx*, ♂), two White-collared Mangabeys (*Cercocebus collaris*, ♂ ♀), a Moustache Monkey (*Cercopithecus cephus*, ♂), from West Africa, presented by Dr. H. O. Forbes; two Tawny Owls (*Syrnium aluco*), European, presented by Mr. T. Guittonnean; a Natal Python (*Python natalensis*) from Natal; a Green-necked Touracou (*Gallirex chlorochlamys*) from East Africa, presented by Mr. W. Champion; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. G. J. W. Vickers; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Major Spilsbury; four Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, a Green-cheeked Amazon (*Chrysotis viridigena*) from Columbia, two —— Terrapins (*Clemmys* ——), deposited; three Bennett's Wallabies (*Macropus bennetti*, ♂ ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SUNSPOTS AND THE MEAN YEARLY TEMPERATURE AT TURIN.—In a small memoir entitled "Sulla relazione fra le Macchie Solari e la Temperatura dell' aria a Torino," Dr. G. B. Rizzo shows in a striking way the effect of the relative frequency of solar spotted area on the Turin temperature. For this investigation he has been able to employ a continuous series of observations, commencing from the year 1752 to the present time, made by Prof. Ignazio Somis, the R. Accademia delle Scienze, and the Astronomical Observatory of Palazzo Madama. The resulting numbers show that not only is the eleven-yearly period plainly marked, but that a well observed "lag" of the temperature is displayed by the observations

Forming the two equations, the first giving the relative frequency of solar spots, namely,

$$r = 46{\cdot}31 + 20{\cdot}70 \sin (184^\circ\, 24' + z),$$

and the second the relative change of temperature, namely,

$$t = 21{\cdot}85 + 0{\cdot}22 \sin (94^\circ\, 53' + z),$$

where z represents the distance in arc from the beginning of an eleven-year period, and forming the differences from the mean value of the whole period, the following table shows the variation recorded.

Year of period.	Deviations from the mean: Spots.	Deviations from the mean: Temperature.
1	− 7·34	+ 0·21
2	− 16·64	+ 0·13
3	− 20·65	+ 0·01
4	− 18·11	− 0·11
5	− 9·82	− 0·19
6	+ 1·59	− 0·22
7	+ 12·50	− 0·17
8	+ 19·42	− 0·07
9	+ 20·20	+ 0·05
10	+ 14·56	+ 0·16
11	+ 4·29	+ 0·22

The author's summary of the investigation leads him to the following conclusion:—

The eleven yearly variations of the sunspots and the mean temperature at the earth's surface are due to some periodic cause, which acting at the sun increases the spots, and on our planet increases the temperature, with a retardation in time of a quarter of this period; on the other hand, a similar cause acts on the earth diminishing the temperature, and on the sun increasing the spots with a like retardation.

RECENT CONTRIBUTIONS TO ASTRONOMY.—Among some of the astronomical pamphlets we have received recently, may be mentioned the following:—"Connaissance des Temps" for the year 1899. Among the additions to this volume one may refer to the epochs for the elongations of the fifth satellite of Jupiter; a series of elements from which can be calculated the exact positions of the satellites of Mars, Saturn, Uranus and Neptune, in which the unpublished results of the researches of M. H. Struve are employed. There is also a table giving the ecliptic elements of the major planets, their satellites, and of Saturn's ring. Of the eclipses mentioned two partial ones occur, the first on January 11 and the second on June 9; the latter is of interest, as it will be visible from Paris.—A pamphlet entitled "Enquêtes et Documents relatifs à l'enseignement supérieur" (vol. lxii.) contains the reports of the different directors on the provincial French observatories for the year 1898. Among those to which reference is made are: Algiers by M. Ch. Trépied, Besançon by M. L. J. Gruey, Bordeaux by M. G. Rayet, Lyons by M. Ch. André, Marseilles by M. Stephan, Toulouse by M. B. Baillaud, and the observatory of Pic du Midi de Bigorre by M. Marchand.—Another publication of interest and utility is that due to the late Dr. E. J. Stone, consisting of tables for facilitating the computation of star-constants. These have been modified and revised by Prof. H. H. Turner, the Savilian Professor of Astronomy at Oxford. Prof. Turner, with the aid of a grant from Miss Bruce, to whom astronomy is very much indebted, has certainly simplified the use of the tables, and they have now been printed in three-figure form which, after considerable use at Greenwich, give satisfactory results "both as regards saving of time and retention of all needful accuracy." We may mention that Prof. Turner has done away with the use of the constants m, n and tan ω, so that the tables will by this alteration be suitable for any epoch.

THE AUGUST METEORS.—As we go to press the swift moving August meteors will be speeding through our atmosphere, rendering themselves luminous to us according as they pass within or without this envelope. As they originate from a point situated near η Persei, lying in the north-eastern part of the heavens, and rather low down in the sky in the earlier part of the evening, the longest trails should be looked for down in the south-western quadrant of the heavens. A long watch on Monday evening from 9 p.m. to 2 a.m. resulted in the observation of only a few real Perseids, though there were several of those which ordinarily would be termed "sporadic," but which, according to that energetic observer Mr. W. F. Denning, would be attributed to fixed radiant points of minor importance. Two cameras pointed to the Cassiopeiæ and Perseus regions of the heavens, and exposed for considerable lengths of time, were not fortunate enough to catch any of the trails. Perhaps other observers elsewhere have been more fortunate. The night, however, was at times very fine, especially after midnight. The moon, being low down in the southward, did not interfere to any extent with the photographic effects. Clouds prevented work at several stations on Tuesday night.

THE ALGOL VARIABLE Z HERCULIS.—Dr. Ernst Hartwig, writing to the *Astronomischen Nachrichten* (No. 3437) about the Algol Variable Z Herculis, draws attention to the fact that this interesting variable is now conveniently situated for good comparisons. From observations of the diminution of the light alone in the first half of the month of June, using the 1894 light curve, it was found that the times for the principal minima differed only a few minutes from the ephemeris given in the *Viertel Jahrschrift*, while the times of the occurrence of the secondary minima, in which the star is only a third of a magnitude below its general brightness, occurred twenty minutes later than the computed times. The length of period, which was published in a previous number of the *Astronomischen Nachrichten* (No. 3260), and the ephemeris based on this, is thus found to be correct to a few seconds.

REPRODUCTION OF COMETARY PHENOMENA.—The following brief notice appeared in the *Times* of August 5:—"A Reuter telegram from Berlin of yesterday's date says: 'According to a communication made by the Royal Observatory, Prof. Goldstein, of this city, has succeeded in experimentally reproducing by means of kathode rays certain very distinct and characteristic cometic phenomena, such as the radiation of light from the head of a comet and the resultant development of a tail. He has also been able by these means to account for certain peculiarities of this class of phenomena which have been observed in recent years.'"

SOME PROBLEMS OF ARCTIC GEOLOGY.[1]

II. FORMER ARCTIC CLIMATES.

IN a summary of the geological history of the Arctic Ocean (*ante*, p. 301) it was remarked that in Silurian times the water was warmer than it is at the present day; and there is no doubt that the climate of the Arctic regions has varied greatly. According to the belief generally accepted there have been periods when the climate of the northern hemisphere was so severe that an ice sheet extended from Ireland to Siberia, from the Thames Valley to the North Pole; and then at other times, as the whole earth enjoyed the doubtful benefits of a tropical climate, Greenland's now icy mountains were bordered by a coral strand. This view of the great variation of Arctic temperature has been so widely held that it has exercised a very great influence on theories of faunal migrations and on the former climates of the world. The volumes which summarise the results of the *Challenger* expedition show to what an extent some of the latest speculations as to climatic change have been influenced by this theory; for in that work Dr. Murray strongly advocates Blandet's suggestion that in late Palæozoic times there was "over the whole globe an almost complete equality in the distribution of light and heat" due to the "very much greater size of the sun in the early stages of the earth's history." And this bigger Palæozoic sun was assumed in order to explain the fact that "the Arctic Ocean was a coral sea in Carboniferous times."

Let us, therefore, briefly consider how far the evidence of Arctic geology supports the statements that have been based upon it in this respect. The theory that the Arctic regions once enjoyed a tropical climate was first advanced on the evidence of some fossil plant beds, of which the most famous occur in Disco Island and neighbouring parts of the coast of Greenland. The fossil plants from these beds were described by Heer, whose conclusions have been summarised by Lyell as follows:—"In this rich flora considerably more than half are trees, which is the more remarkable since trees do not exist in any part of Greenland even 10° further south. More than fifty species of Coniferæ have been found with species of Thujopsis and Salisburia now peculiar to Japan. There are also beeches, oaks, planes, poplars, maples, walnuts, limes, and even a magnolia. Among the shrubs were many evergreens, as *Andromeda* and two extinct genera, *Daphnogene* and *M'Clintockia*, with fine leathery leaves; together with hazel, blackthorn, holly, logwood and hawthorn. *Potamogeton*, *Sparganium* and *Menyanthes* grew in the swamps; while ivy and vines twined around the forest trees, and broad-leaved ferns grew beneath their shade. Such a vigorous growth of trees within 12° of the pole, where now a dwarf willow and a few herbaceous plants form the only vegetation, and where the ground is covered with almost perpetual snow and ice, is truly remarkable."

These statements were so positively made and so fascinatingly sensational, that they have been repeated in every text-book, while the protests against them have been generally ignored. Protests, however, have been often made. The first botanist to visit the Disco plant beds was the late Dr. Robert Brown; and as the result of his investigations he wrote—"I must protest against the way in which Prof. Heer has been making species and genera out of these fossils with a recklessness regardless of consequences." Mr. Starkie Gardner checked a long series of Heer's determinations, and declared them valueless; he remarked that Heer's conclusions were "based upon specimens too fragmentary to be of any value, and belong to types of leaves which are so universal that they would, even if perfect, fall into the undeterminable residuum of a fossil flora." He concluded that at least half of these genera and species of Heer's must be suppressed.

Prof. Nathorst, in whose care Heer's type specimens are now resting, is fortunately undertaking a careful revision of the evidence, and he is as emphatic as Brown and Gardner regarding the unsatisfactory nature of Heer's identifications.

The most important point in this reduction of Heer's species, is that it is the plants which are most indicative of the tropical conditions, such as the palms, which have to be abandoned. That many big-leaved plants grew in areas which now support only an insignificant growth of saxifrages and crucifers, is undeniable; and the leaves in question often present resemblances to those of trees, such as the plane, maple and lime. But palæobotanists now distrust the evidence of leaves alone, which are, moreover, especially untrustworthy in the Arctic regions. If a specimen of a Norwegian shrub that has grown at Tromsö be compared with a specimen of the same species that has grown at Christiania, the former will be seen to have less wood but larger leaves. The continual daylight in the summer has a very stimulating effect on leaf production, and the leaves are larger and fleshier than they would be if once a day their growth were stopped by night.

But it may be said, this will not explain the occurrence of the great tree stems which are found in association with the Arctic coal seams and leaf beds. It was mainly to explain the growth of these tree trunks that Sir John Evans introduced his well-known theory of the shifting of the pole; for at one time it was held that an annual exposure for three months to continuous darkness would have been quite inhibitory to the growth of trees. Botanists, however, now tell us that in a cold climate the winter's darkness would be an advantage to vegetation instead of a fatal objection; and the darkness is actually secured artificially in the gardens of St. Petersburg as a protection to trees. Trees even now do grow beyond the Arctic Circle, and the darkness is no absolute bar to their having ranged many degrees further north. That pines and other conifers did so in the past is proved both by the mode of occurrence of the fossils and by the histological structure of the wood. But that all the trees found buried in the rocks of Spitsbergen and Greenland grew where they now occur is by no means so certain. It is probable that most of them have been carried to their present latitude as drift wood. The famous Forest Bed at Cromer was so named in the belief that it was the site of an old forest; but it is now regarded as an estuarine deposit, formed at some distance from the place where the trees that occur in it grew. Similarly, the description given by Brainerd of the petrified forest found in the north of Greenland by the Greeley expedition is as consistent with the view that the tree trunks were drifted as that they grew *in situ*. In the case of the Disco leaf beds we fortunately have the opinion of a trained botanist, the late Robert Brown. He examined the plant beds especially in reference to this point, and he tells us that not "in any instance did I find the leaves in conjunction with or attached to the stem, by which I could positively say that these were the leaves of the tree to which the stem belonged, or that the stem was brought there, or was in any way connected with the same natural or physical causes which influenced the leaves." Brown quotes, and apparently approves, Steenstrup's remarks, "perhaps they [the leaves] were blown by the wind to their present locality." So Brown saw no evidence that the West Greenland plant beds mark the site of ancient forests.

The quantity of drift wood cast upon the Arctic shores is enormous. Many raised beaches are strewn with pine and larch logs, to which the roots are often attached and are buried in the mud. Mosses and sedges, willows and saxifrages grow upon the beach; their remains, together with wind-borne material, may gradually fill up the spaces between the tree trunks, and the whole may be buried by rainwash from cliffs above the beach, or by tide-borne sand should the beach again sink below sea-level. Under such circumstances an impure coal seam would be formed; and a future geologist might easily be deceived by the numerous tree trunks, and the rich leaf remains, into the belief that at the era of its formation the locality had supported a forest growth, which could not now be paralleled less than 20° further south.

Most of the Arctic drift wood consists of logs of pine and larch from the Siberian forests; but blocks of mahogany from Central America sometimes occur, and West Indian beans are not uncommon. Hence the occasional presence of tree stems of tropical types may easily be explained without assuming any great change of climate. But the action of ocean currents is not the only factor that may have complicated the evidence of these northern plant beds. Many limitations are necessary in the application of fossils to the elucidation of former climates. Genera that once lived in cold regions may now be restricted to the tropics owing to a change in habit; and plants that were once world-wide in distribution may now survive only in a few especially favourable localities. Thus in the Carboniferous period the most abundant ferns belonged to the order Marattiaceæ, of which there are twenty-seven living species; twenty-two of these occur in the torrid zone, three in the south temperate zone, two in the north temperate zone, and there are none in the frigid zone. This does not prove that, wherever Marattiaceæ are found in carboniferous rocks, the climate was

[1] Concluded from page 303.

torrid; it only illustrates the fact that the order was a primitive type once very widely spread throughout the world, and now restricted by the competition of more specialised types. Therefore the occurrence in the Cretaceous rocks of Greenland of the tree-fern *Dicksonia*, which, although it still lives in New Zealand, is said to be most characteristic of the tropical parts of Northern Queensland, is no proof that the Arctic regions had a tropical climate. And it would not be so, even if Sir J. D. Hooker had not warned us, that ferns are the least trustworthy witnesses as to climatic conditions.

Hence an examination of the evidence of the fossil plants of the Arctic regions leads to three conclusions: (1) that, as current opinion rests on Heer's determination of fossil palms and tropical leaves which cannot now be supported, the changes of climate have been greatly exaggerated; (2) that without a complete revision of Heer's work, such as is now being carried out by Prof. Nathorst, the exact extent of the climatic changes cannot be estimated; (3) that the conclusions based on the belief that three months' darkness would be fatal to the growth of trees, cannot be maintained, while most of the fossil tree trunks in question have probably been brought as drift wood from the south.

The fossil faunas of the Arctic regions have been held to demonstrate climatic changes no less enormous than do the fossil floras. The most striking proofs quoted were the asserted occurrence of fossil coral reefs in the Silurian and Carboniferous rocks of various parts of the Arctic area, notably Bank's Land, Grinnell Land, Spitsbergen, and the New Siberian Islands. It is, perhaps, the best-known fact in the science of geographical distribution that coral polypes cannot build coral reefs in water of a lower temperature than 68° F. If, therefore, coral reefs formed by madreporarian corals do occur in the Arctic regions, this would be conclusive evidence of a great change in the temperature of the northern ocean. Let us take the case of the corals of Grinnell Land, of which specimens were brought home by Colonel Feilden, and determined by Mr. Etheridge. The collection included eleven species; of these six were simple corals, one was a simply branching, another was a cluster of simple corals, and the remaining three species, although compound, occurred in small nodules. Of corals in the condition of reef builders, there are none in the collection. Simple corals live in the Arctic ocean at the present day, while compound corals as large as the specimens from Grinnell Land are found far outside the range of existing coral reefs, and at far greater depths. The collection from Grinnell Land gives no proof that coral reefs were ever formed there. We have only to compare the few insignificant species from that region, with the massive corals that lived at the same time in English seas, to realise that there was almost as great a difference between the temperature of the sea in the two areas in Silurian times as there is to-day. Baron von Tol's list of Anthozoa from the Silurian rocks of the New Siberian Islands also includes eleven species; but of these only three are true Madreporaria. Compound Hydrozoa and Alcyonaria have a greater range than the reef-building Madreporaria, both in latitude and depth. Hence, in arguing from the distribution of the fossil corals, we must eliminate all except Madreporaria; and the moment we apply this rule to the New Siberian coral reefs, we lose all but a few small Madreporaria, which certainly cannot be described as forming reefs.

If limestones as full of corals as the Silurian rocks of Wenlock Edge, or some of the beds in the Carboniferous series at Clifton, be ever found north of 80° N. lat., they will no doubt prove that at the time of their formation the Arctic Ocean was a coral sea. But the evidence so far seems insufficient. That the northern seas had a warmer temperature at some parts of the Palæozoic era than at present is not denied. It is proved by the occurrence of coral reefs in various parts of Europe and America; and in places massive corals grew as far north as the Arctic Circle, as in the Timan Mountains, and sometimes even a few degrees beyond, as in Bank's Land. But the northern coral faunas are poorer than those of temperate Europe, and as we go nearer the pole, they become so stunted that they ceased to form reefs.

The corals alone, therefore, are insufficient to prove the universality of a tropical climate in early geological times, and it is advisable to consider the evidence of the fossil faunas as a whole. Arctic marine faunas are known from six of the geological systems—the Silurian, Devonian, Carboniferous (including Permian), Triassic, Jurassic and Cretaceous. The six faunas are characterised by the following general features:—

(1) They are often rich in individuals, but poor in species.

(2) Crustacea, trilobites, zoophytes, and other animals with chitinous exo-skeletons are proportionately common and often large in size.

(3) Compound corals are scarce, and occur in nodules instead of in reef-forming masses.

(4) Sea-urchins and sea-lilies are extremely scarce—in fact, barely represented.

(5) There is a striking poverty in new or special types.

But these are, in the main, the characteristics of the existing Arctic fauna; and it is difficult to compare the Arctic fauna of any one period with that which then lived in southern Europe, without concluding that all through geological time the northern faunas have lived under the blight of Arctic barrenness.

This reminds us of the question of the shifting of the position of the pole, which was proposed as a help to palæontologists in explaining the former Arctic faunas and floras. But the facts seem explicable without the aid of this hypothesis. Neumayr has published a map of the probable climatic zones in the Jurassic period, which appear to have been as parallel to the equator then as they are now. In Tertiary times the evidence of the fossil plants seems to show the same; for, from whatever direction we approach the pole, the fossil floras become sparser and more boreal in aspect, as we may see by a comparison of the plants of Disco Island and Grinnell Land, of the Great Slave Lake and Prince Patrick Land, of Iceland and Spitsbergen, and of Saghalien and New Siberia.

Hence the palæontological evidence, instead of demanding the shifting of the pole, seems to be opposed to this theory, and to show that, in all the periods for which palæontological evidence is available, the pole stood near its present position. Palæontological evidence, moreover, when freed from sensational exaggeration, shows that the variations in the climate of the Arctic region have not been so extreme as have been assumed, and thus it greatly simplifies the discussion of the causes of the changes that have occurred. The size of the Palæozoic sun was increased to warm the Arctic Ocean up to the temperature of a coral sea; the pole was shifted to remove the fatal spell of Arctic night, and clothe parts of the polar lands in subtropical forests. When Lyell proposed to explain the climatic variations by alterations in the position of land and water, he called upon his theory to account for the alternation of a vast polar ice-cap with tropical conditions. Such results could not be explained by the geographical theory, which accordingly fell into disrepute.

But if we call upon that theory to explain changes for which there is valid evidence, it is not improbable that it may not suffice. A different distribution of land and sea, a greater or less elevation of the mountain ranges, a deflection of the ocean currents, the reduction of the ice-covered sea, and the meteorological changes that would be thus produced may, as Lyell thought, be quite sufficient to account for all the climatic variations which the facts of Arctic geology require.

J. W. GREGORY.

THE IRON AND STEEL INSTITUTE.

THE annual summer meeting of the Iron and Steel Institute was held last week at Cardiff. The President this year is Mr. E. P. Martin, who is at the head of the executive of the great Dowlais Iron Works; and it was appropriate, therefore, that the meeting should be held in the commercial metropolis of Wales. The meeting was in every respect most successful, though certainly it fell off somewhat from a technical point of view; but that, after all, was largely due to the weather, it being too hot to sit in a lecture theatre and discuss details of iron and steel manufacture. An unusually large number of members attended, and many of them were accompanied by ladies.

On the members assembling on Tuesday morning, the 3rd inst., they were welcomed by the Mayor of Cardiff, after which Mr. Martin took the chair, and other formal business having been transacted, Mr. Thomas Wrightson's paper, "On the Application of Travelling Belts to the Shipment of Coal," was read. In this he described a new method of placing coal into a ship, expeditiously and without breaking it. The latter is a very important point, as small coal or dust is worth very little; and the old-fashioned method of shooting coal from a staith direct into the hold of a vessel, leads to the formation of a great deal of small coal. The apparatus Mr. Wrightson has designed,

and which is in use on the Tyne, consists of a series of belts or creepers and a continuous chain, with leaves attached, working in a trunk. The coal is lowered on to the belts, and is thus conveyed any required horizontal distance until it reaches the end of the staith or pier against which the ship is moored. One end of the trunk, in which the continuous chain or belt works, is lowered into the hold of the ship, and by means of the trays the coal is lowered down and gently deposited in the required position. The action of the lowering part of the apparatus is similar to that of a grain elevating machine, or of a bucket and ladder dredger; but of course the working is reversed, the material being lowered in place of being raised. The machine in use was said to be capable of dealing with 400 tons of coal an hour, and as, presumably, a machine could be used for each hatch, a vessel of say 2400 tons dead weight, and having three hatches could, we suppose, be brought to her bearings in a couple of hours. In the discussion that followed, the arrangement was rather sharply criticised, but it must be remembered that Cardiff is the home and birthplace of a rival scheme that has been in successful operation for some years. Naturally those who have used the older method and have experienced the benefit of it as compared with the primitive shoots, are loath to change, and it is also natural that the maker of the original apparatus should not welcome a competing scheme with too great enthusiasm. It would seem, however, that the Wrightson invention ought necessarily to have an advantage in point of speed because it is continuous, whilst the work with the older method is intermittent.

Mr. George B. Hammond's contribution, "On the Manufacture of Tin-plates," was an omnibus paper dealing with the subject at large—historically, commercially, and technically. From the historical and technical point of view, there was very little new to say, and indeed the commercial side of the question is already a thrice-told tale of sadness and decay. America was our great customer for tin-plates, and under the enormous impetus given to the industry by the spread of the canning trade in provisions fortunes were made in South Wales, and enormous wages were paid. The inevitable reaction followed. The United States, pursuing their protectionist policy, put an import duty on tin-plates which was absolutely prohibitive, and that market was lost. There were, however, other outlets for the commodity, and had both employers and employed recognised the need of hard work and frugality the trade need never have fallen to the low ebb it has. Over-prosperity had, however, destroyed the moral fibre of those who had experienced it. There were large profits, high wages, antiquated methods, and artificial restrictions to output which no one wished to forego, and the consequence is that South Wales sees every prospect of American competition in neutral markets. This, however, is somewhat beside Mr. Hammond's paper; but it would be difficult for us to deal with the technical part without the illustrations of machinery which accompanied the paper.

On the following day, Wednesday, the first paper taken was that of Prof. Honoré Ponthière, "On a Thermo-chemical Study of the Refining of Iron." It was read in brief abstract by Mr. Brough in the absence of the author. From its title it will be seen how impossible it would be to abstract such a subject within anything approaching the limits of space at our disposal. It began with a discussion on the conditions under which the elements exist in iron, and treated of the various possible or probable reactions which take place during the process of steel-making by the two chief processes, and of puddling.

Mr. E. H. Saniter's paper "On Carbon and Iron" followed, being read in full by the author. This was the most important contribution to the meeting. It discussed the thermal treatment of tri-basic carbide of iron; the saturation point of iron with carbon by fusion in contact with excess of carbon; the saturation point of iron with carbon by heating without fusion in contact with excess of carbon; and the etching of pure carbon alloys at a red-heat in order to ascertain their structure by means of the microscope at that temperature. The last branch of the subject brought forward points of considerable interest, and the paper raised the old, and it would seem interminable, controversy on the alpha and beta states of iron. Mr. Saniter, we gather, is more of a carbonist than an allotropist, and his reasoning seemed to support the former party. Unfortunately there were no allotropists present, or if there were they were silent; so the discussion went all one way. The photo-micrographs attached to the paper were interesting, and in some respects this new method of treatment showed unexpected results. Mr. Saniter made a strange mistake in his paper. He attributed to so competent an authority as Edward Riley the statement that the saturation-point of iron for carbon was 4 per cent. Mr. Riley, who was present, naturally exclaimed against this, and asked Mr. Saniter for his authority, which the latter gave as the Journal of the Institute for the year 1877. What the saturation-point may be has not, we believe, been exactly determined, but at any rate it is higher than 4 per cent. Mr. Saniter's mistake, of course, was that he did not verify his authority when the statement was so questionable and the reference to the original so easy.

The last paper read at the meeting was Mr. Henning's contribution on a recorder of stretching, which was taken charge of by Mr. Wicksteed, in the absence of the author. The portable recorder referred to consists of a pair of clamps attached to the two ends of the specimen rod. To one of these clamps is attached a parallel motion with a projecting arm, at the end of which is a pencil. The motion is worked by rod from the other clamp, so that when the specimen stretches, and the clamps are thus pulled apart, the arm moves. In this way a record can be obtained on a card which is mounted on a revolving drum, which is actuated by a cord from the poise weight. It will be seen that in construction the apparatus bears a resemblance to a steam engine indicator, both in regard to the parallel motion and the paper-drum. It was objected during the discussion that the poise could not be moved fast enough to give true indications when the specimen ultimately gave way; but probably if a record can be obtained within the elastic limit, that will be sufficient for the majority of engineers, as a material strained beyond this limit is very little good for structural purposes.

Five other papers were on the agenda, but were not read at the meeting.

The excursions and entertainments during this meeting were numerous and the hospitality profuse. Several of the large iron and steel works were visited, the Cardiff and Newport docks were inspected, and also other places of industrial interest. There were lunches, dinners, soirées, a Welsh concert, garden parties, and illuminations packed in as close as time would permit; but the culminating point in all these delights was the Marchioness of Bute's ball. To this over three thousand guests, including all the members of the Iron and Steel Institute and the ladies accompanying them, were invited.

ON PRACTICALLY AVAILABLE PROCESSES FOR SOLDERING ALUMINIUM IN THE LABORATORY.

IT seems that ever since the metal aluminium has been used in construction, difficulties have arisen in soldering it. Further, from contemporary literature it appears probable that some perfectly satisfactory methods of getting over the difficulty are known, but not published in sufficient detail to be available.

Hence it seems well to put on record any advance towards the solution of this somewhat troublesome problem. In the first place, my experience is that it is not easy to solder aluminium simply by using an alloy of definite composition without a flux. Also that the only other process which does not require special apparatus, that based upon the use of silver chloride, is very troublesome indeed unless the local fusion of the aluminium be immaterial. I find, however, that cadmium iodide is distinctly more satisfactory. If it be fused on an aluminium plate, decomposition of the salt occurs long before the melting point of the aluminium is reached. The result is generally the violent evolution of iodine vapour and formation of an alloy of cadmium and aluminium on the surface of the metal.

The decomposition of the cadmium iodide is, however, too rapid to be convenient, and the pulverulent white residue is in the way. It is, therefore, of advantage to add some other body which, if possible, will obviate these defects. I find that zinc chloride answers fairly well. Thus I mix concentrated zinc chloride solution with a little ammonium chloride, evaporate in a round porcelain dish, and ignite a low red heat till a part of the ammonium chloride is volatilised. The fused chlorides are now mixed with cadmium iodide. The proportions of zinc chloride and cadmium iodide are best adjusted experimentally.

The final result, when the salts are completely fused together, is a flux which readily enables tin (or other soldering alloy) to unite perfectly with aluminium. The melted flux can be taken up in a pipette with india-rubber teat, and dropped on to the surface of the metal to be soldered. Some powdered metallic

tin is also sprinkled on the surface. The aluminium is then heated over the Bunsen flame till the flux just melts; it can then be quickly spread where it is wanted with a piece of copper wire or thin glass rod. As the temperature is further raised the flux decomposes, and the tin readily alloys itself with the surface of the aluminium; while the flux is decomposing, the tin can be spread in a continuous layer by means of the little glass rod or wire.

Instead of cadmium iodide, fused lead chloride may be used in a similar manner.

I should like to substitute some of the less volatile alkyl-ammonium chlorides for the ammonium chloride, but have not had opportunity.

A. T. STANTON.

THE STUDY OF NATURAL HISTORY IN JAPAN.

A NEW publication, entitled *Annotationes Zoologicae Japonenses*, has just been launched at Tokyo, under the auspices of the Zoological Society there. In 1888 the Society commenced the issue of a monthly journal—the *Dōbutsugaku Zasshi* (*Zoological Magazine*)—in the Japanese language, and the periodical is now in its ninth volume. About two years ago a department written in European languages was added to the magazine, and the new publication may be regarded as another step forward in the same direction. The old and the new magazines will be carried on as separate publications; but while the former will be exclusively intended for Japanese students, the latter will be issued primarily for the purpose of making the progress of zoology in Japan better known outside that country. For the present, the *Annotationes* will be published quarterly, and the intention is to widely distribute it among all institutions and societies interested in zoological progress. In the future, therefore, zoologists may chiefly look for contributions to their branch of science from Japanese sources in two publications, viz. in the *Journal* of the College of Science, Imperial University, for elaborate memoirs, and in the new periodical for shorter notices and papers. Other publications, such as the *Bulletin* of the College of Agriculture, will, of course, occasionally publish articles on zoological subjects as heretofore.

In introducing the new journal, and defining its aim and scope, Dr. K. Mitsukuri, Professor of Zoology in the Imperial University, and President of the Tokyo Zoological Society, gives a brief retrospect, which is abridged below, of the progress of zoology in Japan.

It is probably unknown to most persons in the West that early in the eighth century of the Christian era there was already established in Japan an Imperial University with four departments—Ethics, History, Jurisprudence, and Mathematics—and with the prescribed number of four hundred students. There were also, at the same time, a bureau devoted to Astronomy, Astrology, Calendar-compilation and Meteorology, and a Medical College with professors of Medicine, Surgery, Acupuncture, Necromancy (the art of healing by charms), and Pharmacology. The last-named branch of study included the collection, cultivation, and investigation of medicinal plants, and thus a considerable amount of botanical knowledge must already have been acquired by that time. Towards the end of the ninth century, when a catalogue of books existing in Japan was compiled by the order of the then reigning Emperor, the Imperial library was found to contain 16,790 volumes, divided into forty departments—and this in spite of a disastrous fire of some years previous. Among the medical works were some with very modern sounding titles, such as "The Curing of Diseases of Women," and "On the Methods of Healing Diseases of the Horse." Japan in those early days derived its culture from India, China, and Korea; but the details above enumerated clearly show that educated society must already have attained a high degree of civilisation.

Coming to more modern times, it is known that, during the long peace of two hundred and fifty years which the rule of the Tokugawa *shoguns* secured for Japan, literature, the arts, and all peaceful industries were developed with remarkable vigour and rapidity, and that the study of natural history shared in this progress. Apart from that innate love of nature and the natural which was ever showing itself in poetry and other arts, the study of natural products was always pursued, ostensibly with the purpose of collecting *materia medica*, or of discovering things that might be used as food in case of a famine, or of identifying objects mentioned in the Confucian classic, "Shi-King." But it is not difficult to perceive that naturalists looked in reality beyond these simple or utilitarian ends, and investigated animals and plants for their own sake, although the principal aim of their researches seems to have been the comparatively barren one of establishing a relationship between Japanese products and those described in various Chinese works on natural history. Frequent were the excursions and expeditions undertaken with the view of collecting natural objects, among which plants were especial favourites, and all parts of the country seem to have been tolerably well explored in this way. Numerous were the treatises on natural history, published or unpublished. Many of these were encyclopædic in their comprehensiveness and size, such as "Shobutsu Ruisan," by Inao Jakusui (1000 parts, early in the eighteenth century), and "Honzō Kōmoku Keimō," by Ono Ranzan (48 parts, 1803). The last-named naturalist was so famous for his extensive knowledge that, we are told, his pupils were nearly one thousand in number. Prof. Matsumura, in his book on the enumeration of Japanese plant-names, gives 306 titles of Japanese works on botany compiled previously to 1868. Many of the natural history volumes had beautiful coloured illustrations, which serve their purpose even at the present day. natural history displays were of common occurrence, when naturalists came together with their treasures, and showed them to one another and to the public. Of these the exhibitions given by Hiraga Gennai in the middle of the eighteenth century were perhaps the most celebrated. The present Botanic Garden of the Imperial University was established early in the Tokugawa period, viz. in 1681, and was long renowned as the "O Yaku En" (Garden of Medicinal Plants). The mastery of the Dutch language by a few earnest physicians in the middle of the eighteenth century is one of the greatest triumphs ever achieved by patient scholarship. Originally undertaken with the purpose of ascertaining something about Western medicine, their efforts soon exerted an influence on all branches of learning. The whole rich treasury of Western civilisation became suddenly accessible through the channel thus opened of the Dutch language. It is not possible to over-estimate the effect of the new acquisition on the progress of Japan. Suffice it to say that the country would not be what it is to-day but for this leaven which had been working through and through the whole mass of society for over a hundred years before the Restoration of 1868 enabled it to bear its legitimate fruit. This innovation, together with the visits of Thunberg (1775) and Siebold (1821), had due effect upon the natural history studies also. The system of Linné, especially in regard to plants, seems to have been well grasped, with very little delay. The most famous productions of the new school on natural history subjects are probably "Shokugaku Keigen" (Elements of Botanical Science) by Udagawa Yoan, 1835; and "Sōmoku Zusetsu" (Icones Plantarum) by Iinuma Yokusai, 1832—the latter being a standard work at the present day. It is perhaps a circumstance interesting enough to record that a work on the use of the microscope was published in 1801.

Looked at from the modern standpoint, the natural history of the pre-Restoration period (before 1868) was without doubt strongest in botany. The science of zoology seems to have been greatly backward in its development compared with that of the sister science, and its study was probably similar in method and aim to that of the Middle Ages in Europe. It seems to have concerned itself mostly with making commentaries on Chinese works of natural history, like "Honzō Kōmoku," or with identifying Japanese objects with names given in those writings. Excepting a little on birds, fishes and shells, hardly any work that can be called scientific, in any modern sense, seems to have been accomplished. Nevertheless this school did an immense service by showing that the study of natural objects was worth the best efforts of intellectual men. Names like Arai Hakuseki, Inao Jakusui, Kaibara Ekken, Ono Ranzan,[1] are among the most honoured in the annals of our learning.

With the restoration of the Emperor to his full power, in 1868, came the wholesale reconstruction of all political institutions, and the country has been, and is still, going through such a social revolution as has seldom been witnessed in any part of the world. Along with many other things, the old school of

[1] All these names are given in the Japanese fashion, with the surname first.

natural history was swept away, as chessmen from the board at the end of a game. So for as our science is concerned, there is a complete break at this period. The modern school of zoology dates from the appointment of Prof. E. S. Morse, of Salem, Mass., U.S.A., to the chair of Zoology at the University of Tokyo, in 1877. His indefatigable zeal and genial manners won many friends for the new science among all classes of society, while his lectures, popular or otherwise, drew attention for the first time to the immense strides which our science, under the stimulus of Darwinism, was making in the West. He, with a few students under him, also soon had in working order a tolerably good museum—the nucleus of the present zoological and anthropological collections of the Science College. It was also during his stay and through his care that the Tokyo Biological Society, from which the Tokyo Zoological Society is directly descended, was first organised. It is truly wonderful how much he accomplished in the brief time he was in Japan. On the return of Prof. Morse to America, he was succeeded by Prof. C. O. Whitman, now of the University of Chicago. It was the latter who first introduced modern technical methods. These two Americans, Morse and Whitman, thus stood sponsors to the modern school of zoology in Japan.

Since 1881, the development of zoology in Japan has been entirely in the hands of Japanese.[1] The spirit of earnest study which signalised the natural history school of the pre-Restoration days is happily revived, but with higher and wider purposes, and with greater facilities for successful attainment. Though only twenty years have passed since the "new departure," a vigorous school of zoology has already sprung up.

There can be no doubt that the establishment of the marine station at Misaki, by the Imperial University, in 1887, gave a great impetus to the study of zoology in Japan. Situated at the point of the peninsula jutting out between the Bay of Sagami and the Bay of Tokyo, it has access to localities long since famous as the home of some remarkable forms of animal life. Along the coast, all sorts of bottoms are found, yielding a rich variety of animal forms, while the hundred-fathom line is within two or three miles of the shore, and depths of five hundred fathoms are not very difficult of approach. The existence of a remarkable deep-sea fauna in these profounder parts has been ascertained within the last few years, and zoological treasures are now being constantly hauled up. The great "Black Current" (*Kuro Shiwo*) sweeps by, not many miles out, and a branch of it often comes right into the harbour of Misaki, gladdening the heart of the Plankton collector. Face to face with this inexhaustible treasury of animal forms, the zoologist will have to possess unusual powers of self-restraint, indeed, not to grow enthusiastic over his science.

The prospects of zoological science in Japan have never been brighter than they are at this time. All of its main branches, including applications of it to practical purposes, such as fisheries, sericulture, entomology, &c., are now fairly represented. Each year will see gradual additions to the specialists of different groups, as the number of graduates from the Imperial University increases. The marine station at Misaki, which has become too small for our growing body, will be removed within the present year to a new site, about two miles north of its present location, and its accommodations will be considerably enlarged. While perhaps not essential to the pursuit of science, the extreme beauty of the situation, which commands a matchless view of Fujiyama and the Sagami Bay, will certainly not lessen its attractions; and an additional charm to those who are interested in the heroic achievements of the past may be found in the historical associations with which the spot abounds. A proposed railway, passing near the new site, will bring the station within two or three hours of Tokyo. A number of teachers, scattered over different parts of the country, are acting somewhat as sentinels at the outposts of zoology, and doing good service in collecting animals from different localities. The field of activity has also lately been suddenly widened by the addition of Formosa to the territory of Japan, and the work of a collector now on that island will, it is hoped, be but the forerunner of many similar undertakings.

[1] Some who read this statement may consider that I have not given due credit to those zoologists from other countries who have lived in, or visited, Japan from time to time. It is certainly as far as possible from my intention to slight the labours of Hilgendorf, Döderlein, Pryer and others, but the fact remains that the recent development of the zoological school in Japan has been almost entirely independent of these men. It is a pleasure to me to add that Mr. Owston, of Yokohama, has been very active in unearthing the treasures of the deeper parts in the Sagami Sea.—K. MITSUKURI

THE WORSHIP OF METEORITES.[1]

HERE is a small fragment of iron that has a curious history. It is a portion of a mass of meteoric iron found upon a brick altar in one of the Ohio mounds. Along with it were various objects—a serpent cut out of mica—several terra-cotta figurines—two remarkable dishes carved from stone into the form of animals; pearls, shells, copper ornaments, and nearly three hundred ankle bones of deer and elk. There were but one or two fragments of other bones, and one animal furnished but two of these ankle bones; hence they must have been selected for some special, important reason. The figurines had been apparently broken for some purpose, and the whole collection had suffered in the fire not a little. In a like altar of another mound of the same group were found nearly two bushels of like objects.

It must have been in some ceremony of a religious, possibly one of a funereal, character that the mound builders collected here on the altar their ornaments and other valuables, and after burning them buried the charred débris in the huge earthen mound that was built over them and the altar.

What would we not give if this fragment could be endowed with the power of repeating to us its experience—chapters in the history of that people? But nearly all that we can say is that it was found among objects held by them in peculiar esteem, and used by them in some serious, probably religious ceremony.

There was formerly, and so far as I know there is still, in the collection of meteorites in Munich, a stone that weighs about a pound. It fell in 1853 in the region north of Zanzibar, on the East African coast, and was seen and picked up by some shepherd boys. The German missionaries tried to buy it, but the neighbouring Wanikas, because it fell from heaven, took it to be a god. They secured possession of it, anointed it with oil, clothed it with apparel, ornamented it with pearls, and built for it a kind of temple to give it proper divine honours. The agents of the missionaries were not allowed even to see the stone, far less could they purchase the Wanika's tutelar deity. Neither entreaties, nor arguments, nor offers of the missionaries, nor of the officials were of any avail. But when three years later the wild nomad tribes of the Masai came down upon the Wanikas, burned their village, and killed large numbers of them, the Wanikas thought very differently of the stone's protecting power. In fact they lost all respect for it. A famine having meanwhile arisen, the elders of the tribe were quite ready to exchange their palladium for the silver dollars of the missionaries.

Among the Buddha legends is one of two merchants who offered food to the Buddha, which was accepted, and in consequence of their request for some memorial of him the Buddha gave them a hair and fragments of his nails, and told them that hereafter a stone should fall from heaven near the place where they lived, and that they should erect a pagoda and worship these relics as though they were Buddha himself.

The nations of India have always been specially superstitious about stones fallen from the skies. In 1620 an aerolite fell near Jullunder, and the king sent for a man well known for the excellent sword blades that he made, and ordered him to work the lump into a sword, a dagger and a knife. The mass, however, would not stand the hammer, but crumbled in pieces. By mixture with iron of the earth the required weapons were made.

In 1867 a shower of stones fell, some forty in number, at Saonlod. The terrified inhabitants of the village, seeing in them the instruments of vengeance of an offended deity, set about gathering all they could find, and having pounded them into pieces they scattered them to the winds.

In 1870 a meteorite fell at Nidigullam, and the Hindoos at once carried it to their temple and worshipped it. The same has been repeated in India on the occasion of several other stonefalls in the present century. One native ruler refused to allow a stone to be carried across his territory for fear of the injury that might come to his people or his lands.

Two Japanese meteorites, formerly the property of a daimio family, were long kept and handed down as heirlooms, being in the care of the priests in one of the family temples. They were among the family offerings made to Skokujo on her festival days. They were connected with her worship by the

[1] A lecture delivered in New Haven, Conn., by the late Prof. Hubert A. Newton. (Reprinted from the *American Journal of Science*.)

belief that they had fallen from the shores of the Silver River, Heavenly River, or Milky Way, after they had been used by her as weights with which to steady her loom. One of these stones was presented by its late owner to the British Museum, and it is in its collection of meteorites.

There is a curious institution among the Chinese that has existed, according to Biot, from a time more than one thousand years before Christ. The Chinese attributed to different groups of stars a direct influence upon different parts of the empire. Some of these groups correspond, for example, to the imperial palaces, to the rivers, the roads, and the mountains of China. By reason of this belief, regular observations are made by the imperial astronomers of all that passes in the heavens, especially of the groups of stars in which comets and meteors originate, or across which they travel. The interpretation of what is seen in the sky forms part of the duties of these very important officials. These observations have been carefully written out, and are preserved in the archives of the empire. Upon the ending of a dynasty, by change of name or otherwise, these comet and meteor records have been published as a special chapter of the chronicles of the dynasty. The existing dynasty began in 1647, since which date the records are, therefore, unpublished.

In 1492 a stone of 300 pounds weight fell at Ensisheim, in Alsace. The Emperor Maximilian, then at Basel, had the stone brought to the neighbouring castle, and a Council of State was held to consider what message from heaven the stonefall brought to them. As a result, the stone was hung up in the church with an appropriate legend, and with strictest command that it should ever remain there intact. It was held to be an omen of import in the contest then in progress with France and in the contest impending with the Turks. Nineteen years later a shower of stones fell near Crema, east of Milan. The Pope was at war with the French, and the stones fell into the French territory. Before the year had passed the French, after a long possession of Lombardy and serious threatening of the States of the Church, were forced to retire from Italy. At this time Raphael was painting for an altar-piece his magnificent Madonna di Foligno, now in the Vatican. Beneath the rainbow in the picture, indicating divine reconciliation, Raphael painted also this Crema fireball, apparently to set forth divine aid and deliverance.

I have thus rapidly gone over some selected facts, showing how the mound builders, the wild Africans, the Hindoos, the Japanese, the Chinese, the modern Europeans have been ready to revere these mysterious bodies that come from the skies. But it is in the Greek and Latin literature that we have reason to expect the more numerous and full accounts, both legendary and historic, of this reverence and worship.

It is now, I believe, admitted by the best scholars that both in Greece and in Italy, there was a period earlier than the age of images, when the objects worshipped were not wrought by hand. Men worshipped trees and caves, groves and mountains, and also unwrought stones. Even after men began to make their objects of worship, these were in many cases mere hewn stones, not images. The earlier Greek term ἄγαλμα, an object of worship, stands apart from the later term εἰκών, image.

What would be more natural in that age to the affrighted witnesses of the most magnificent of spectacles, the fall of a meteorite, than for them to regard the object which had come out of a clear sky, with terrific noise and fire and smoke, as something sent to them by the gods to be revered and worshipped? It was nobler to worship a stone fallen from the sky than one of earthly origin.

The worship of an unwrought stone once established has wonderful vitality. For example, the Greek writers speak of such a worship in their day among the Arabian tribes. When Mohammed, with his intense iconoclasm, came down upon Mecca and took the sacred city, he either for reasons of policy, or from feeling, spared the ancient worship of this black stone. Entering into the sacred enclosure, he approached and saluted it with his staff (where it was built into the corner of the Kaaba), made the sevenfold circuit of the temple court, returned and kissed the stone, and then entered the building and destroyed the 360 idols within it. To-day that stone is the most sacred jewel of Islam. Towards it each devout Moslem is bidden to look five times a day as he prays. It is called the Right Hand of God on Earth. It is reputed to have been a stone of Paradise, to have dropped from heaven together with Adam. Or, again, it was given by Gabriel to Abraham to attest his divinity. Or, again, when Abraham was reconstructing the Kaaba that had been destroyed by the deluge, he sent his son Ishmael for a stone to put in its corner, and Gabriel met Ishmael and gave him this stone. It was originally transparent hyacinth, but became black by reason of being kissed by a sinner. In the day of judgment it will witness in favour of all those who have touched it with sincere hearts, and will be endowed with sight and speech. The colour of this stone, according to Burckhardt, is deep reddish brown, approaching to black; it is like basalt, and is supposed by some to be a meteorite.

It is not important for my purpose to separate the history from the myth. Eusebius quotes from an old Phœnician writer, Sanchouniathon, that the goddess Astarte found a stone that fell from the air, that she took it to Tyre, and that they worshipped it there in the sacred shrine. We have reason to question whether that Phœnician writer ever lived. What matters it? The existence of the story in Eusebius' time has to us a significance not greatly unlike that of the existence of the worship itself in the earlier years.

Virgil describes a detonating meteor in such terms that I feel reasonably sure that either he had seen and heard, or else he had had direct conversations with others who had seen and heard, a splendid example of these meteors. The passage is in the second book of the Æneid. The city of Troy was captured and was burning. All was in confusion. The family of Æneas was gathered ready for flight, but Anchises would not go. An omen, lambent flames on the head of his grandson, began only to shake his purpose to perish with his country. He prayed for more positive guidance. It is Æneas who describes the scene:

"Hardly had the old man spoken when across the darkness a star ran down from the sky carrying a brilliant light torch. We saw it go sweeping along above the roof of the house. It lighted up the streets, and disappeared in the woods on Mount Ida. A long train, a line of light, remained across the sky, and all around the place was a sulphurous smell. A heavy sound of thunder came from the left. Overcome now, my father raised his hands to heaven, addressed the gods and worshipped the sacred star. 'Now, now,' he cried, 'no longer delay.'"

This story is, of course, all legendary, but Virgil's description of the scene is true to life as conceived by pagan Rome in his day.

The images that fell down from Jupiter, or that fell from the skies, are often spoken of by Greek and by Latin writers. I mention three or four cases only where this allusion points to a meteoric origin as possible or probable. The earliest representative of Venus at old Paphos, on the island of Cyprus, was one of these heaven-descended images. It was not the Venus of the Capitol, nor the Venus of Milo, but as described was a rude triangular stone.

Cicero, in the grand closing passage of his oration against Verres, calls upon Ceres, whose statue he says was not made by hands but was believed to have fallen from the skies. The earliest of the images of Pallas at Athens was said to have had a like origin. Pausanias saw at Delphi a stone of moderate size which they anointed every day, and covered during every festival with new shorn wool. They are of opinion, he adds respecting this stone, that it was the one given by Cybele to Saturn to swallow as a substitute for the infant Jupiter, which Saturn after swallowing vomited out on the earth.

There is a marvellous story of a peculiar stone in the poem Lithika by the apocryphal Orpheus. Phœbus Apollo gave the stone to the Trojan Helenus, and Helenus used it in soothsaying. It was called Orites, and by some *Siderites*. It had the faculty of speech, and when Helenus wished to consult it he performed special ablutions and fasts for twenty-one days, then made various sacrifices, bathed the stone in a living fountain, dressed it and carried it in his bosom. The stone now became alive, and to make it speak he would take it in his arms and dandle it, when the stone would begin to cry like a child for the breast. Helenus would now question the stone, and receive its answers. By means of these he was able to foretell the ruin of the Trojan State. Whoever framed that story had, I believe, before him a real stone, and the description is very like that of a meteorite, saying nothing of its having come from Apollo. The Orphic writer says that it was rough, rounded, heavy, black, and close-grained. Fibres like wrinkles were drawn in circular forms over the whole surface above and below.

Here I show you a stone such as was described—rounded,

black, heavy, close-grained, and having fibres like wrinkles in circular forms over the whole surface above and below.

The name *Siderites* was at a later date applied to the loadstone, but by this writer the two stones are separately described, and are apparently distinct. If this name was of Greek origin it seems to be allied to *sideros*, *iron*, and this heavy stone, like nearly all meteorites, probably contained iron. If, however, this name came from a Latin source (for it is used both by Greek and by Latin writers) it has affinities with *Sidus*, a star, and its meteoric character is still more clearly indicated.

One of the most interesting of the stories about images that have fallen from heaven, is the basis of that beautiful tragedy of Euripides. "Iphigeneia in Tauris." To many of you the story is familiar, but it will bear repetition.

The goddess Diana detained at Aulis the Grecian fleets by contrary winds, and required the sacrifice of Iphigeneia, the daughter of Agamemnon, before the Greeks could set sail. The father consented; and the daughter, apparently sacrificed, was really rescued by Diana, and borne to the Tauric, or Crimean peninsula on the north shore of the Black Sea. She was then made a priestess in the temple of the goddess. At this shrine the barbaric inhabitants used to sacrifice before an image of Diana, that fell from heaven, all strangers that were shipwrecked upon the coast. The unhappy Iphigeneia, forced to take a leading part in these human sacrifices, laments her sad lot:—

> "But now a stranger on this strand,
> 'Gainst which the wild waves beat,
> I hold my dreary, joyless seat,
> Far distant from my native land;
> Nor nuptial bed is mine, nor child, nor friend.
> At Argos now no more I raise
> The festal song in Juno's praise;
> Nor o'er the loom sweet sounding bend,
> As the creative shuttle flies,
> Give forms of Titans fierce to rise,
> And dreadful with her purple spear
> Image Athenian Pallas there.
> But on this barbarous shore
> Th' unhappy stranger's fate I moan,
> The ruthless altar stained with gore,
> His deep and dying groan;
> And for each tear that weeps his woes,
> From me a tear of pity flows."

Orestes, the brother of Iphigeneia, had avenged upon his mother the murder of his father. For this he was driven by the Furies. While stretched before the shrine of Phœbus he heard the divine voice from the golden tripod, commanding him to speed his way to the wild coast of the Taurians, thence to take by fraud or by fortune the statue of Diana that fell from heaven, and carry it to Attica. Doing this he should have rest from the Furies.

He was captured, however, along with his friend Pylades, and brought to the altar to be sacrificed. The relationship of the brother and sister became here revealed, and they together fled, carrying with them the image. It was not without a struggle that they reached the shore, but finally,

> "On his left arm sustained
> Orestes bore his sister through the tide,
> Mounted the bark's tall side and on the deck
> Safe placed her and Diana's holy image
> Which fell from heaven."

Neptune favoured the Greeks, Minerva forbade pursuit, and the image was borne to Halae (or as some said to Brauron) in Attica.

Cicero spoke of the Trojan Palladium as something that fell from the sky: *quod de coelo delapsum*. Other classical writers, notably Ovid, speak of it in similar terms. The story in its various forms points toward a stonefall as its basis. One form of it runs thus:—

Pallas and her foster sister Athena were wrestling with each other, when Pallas was accidentally killed. In grief Athena made an image of Pallas and set it up on Olympus. When King Ilus was about building his city on the Trojan plain he prayed for a favourable omen. In response to his prayer Jupiter cast this image down at the feet of the suppliant king. In the new city it was set up in a temple specially erected to contain and protect it. So long as Troy could keep safely this image, the city, it was firmly believed, could not be taken by its foes.

According to one story, the Greeks stole the image before capturing the city. As many cities afterwards claimed to possess the treasure as claimed to be the birthplace of Homer. According to the Romans, Æneas carried the Palladium to Italy, and the image was regarded as the most sacred treasure of the Roman State. For centuries even in historic times it was so carefully kept by the Vestal Virgins that the Pontifex Maximus was not allowed to see it.

We naturally have doubts about the nature, or even the existence, of an object so kept out of sight. What it was that the Vestals thus guarded, or whether they had anything to represent the image of Pallas, will probably never be known. But it is far otherwise with another famous object of Roman worship. To the east of the Trojan plain on which the Palladium fell, rise the mountains of Phrygia and Galatia. In Pessinus, near the border line of these two countries, and in the caves and woods near Pessinus, the goddess Cybele, the mother of the great gods, Jupiter, Neptune and Pluto, was specially worshipped. This worship may not have been more degrading than the worship of many other Asiatic divinities. But it was wretched and unmanly almost beyond our possible conception. It furnished to Catullus the theme for the most celebrated of his poems, one of the strongest pictures in all literature. The Grecian athlete entered her service with joyful music and dancing. Too late he looks back from the Asiatic shore, out of his hopeless degradation, on the nobleness of his former Grecian life. The lion of Cybele drives him in craven fear again into the wild woods, to spend his days in the menial servitude. The Roman poet exclaims, "O goddess, great goddess Cybele, goddess queen of Dindymus; far from *my* house be all thy frenzies; others, others, drive thou frantic."

At some unknown early time a meteoric stone fell near to Pessinus. It was taken to the shrine of Cybele, and there set up and worshipped as her image. This image and its worship very early attained a wide celebrity. About two hundred years before Christ, in the time of the second Punic war, the stone was transported to Rome. The detailed history of the transfer is given by several writers in varied terms. It forms one of Livy's charming stories, it is told in poetic terms by Ovid, it is given as a tradition by Herodian. For every detail of the history I do not ask confiding belief, but the principal event is, I suppose, historically true.

In the year 205 before Christ, Hannibal had, since crossing the Alps, been holding his place in Italy for more than a dozen years, threatening the existence of the Roman State. The fortunes of war were now somewhat adverse to the Carthagenian general. A shower of stones alarmed the Romans. The decemvirs consulted the Sybilline books, and there found certain verses which imported that whensoever a foreign enemy shall have carried war into the land of Italy he may be expelled and conquered if the Idæan mother be brought from Pessinus to Rome. These words were reported to the Senate. Encouraging responses came at the same time from the Pythian oracle at Delphi.

The Senate set about considering how the goddess might be transported to Rome. There was then no alliance with the States of Asia. But King Attalus was on friendly terms with the Romans because they had a common enemy in Philip II. of Macedon. The Senate, therefore, selected an imposing embassy from the noblest Romans. A convoy of five quinqueremes was ordered for them, that they might make an appearance suited to the grandeur of the Roman people. The embassy landed on their way and made inquiry of the oracle at Delphi, and were informed "that they would attain what they were in search of by means of King Attalus, and that when they should have carried the goddess to Rome they were to take care that whoever was the best man in the city should perform the rite of hospitality to her." The king received them kindly, but refused their request; whereupon an earthquake tremor shook the place, and the goddess herself spoke from her shrine, "It is my will, Rome is a worthy place for any god; delay not." The king yielded; a thousand axes hewed down the sacred pines, and a thousand hands built the vessel. The completed and painted ship received the stone, and bore it to the mouth of the Tiber.

It was the spring of the following year before the ship arrived. Meanwhile new prodigies frightened the people. A brilliant meteor had crossed Italy from east to west, a little south of Rome, and a heavy detonation followed. From this, or from some other meteor, another shower of stones had fallen. In expiation, according to the custom of the country in case of stonefalls, religious exercises during nine days were ordered. The Senate after careful deliberation selected one of the Scipios, deciding that he of all the good men in the

city was the best, and they deputed him to receive the stone. The whole city went out to meet the goddess. Matrons and daughters, senators and knights, the vestals and the common people all joined the throng. But a drought had reduced the water of the Tiber so that the vessel grounded upon the bar. All the efforts of the men pulling upon the ropes failed to move it. A noble matron who had been slandered stepped forward into the water. Dipping her hands three times into the waves and raising them three times to heaven, she besought the goddess to vindicate her good name if she had been unjustly slandered. She laid hold of the rope and the vessel followed her slightest movement, amid the plaudits of the multitude.

Scipio, as he had been ordered by the Senate, waded out into the water, received the stone from the priests, carried it to the land, and delivered it to the principal matrons of the city, a band of whom were in waiting to receive it. They, relieving each other in succession and handing it from one set to another, carried it to the gates of the city, and thence through the streets to the temple of Victory on the Palatine Hill. Censers were placed at the doors of the houses wherever the procession passed, and incense was burned in them, all praying that the goddess would enter the city with good will and a favourable disposition. The people in crowds carried presents to the temple. A religious feast and an eight days' festival with games were established to be celebrated thereafter each year in the early part of April.

Before another year had passed Hannibal, after having maintained his army in Italy for fifteen years, was forced to withdraw again to Africa. From the liberal offerings of the people, in gratitude for deliverance, a temple was erected to Cybele, long known as the Temple of the Great Mother of the Gods, so that twelve years after its arrival at Rome the stone was taken from the Temple of Victory and set up in its new home. A silver statue of the goddess was constructed, to which the stone was made to serve in place of a head. Here, in public view, for at least five hundred years that stone was a prominent object of Roman worship. Its physical appearance is described by several writers. It was conical in shape, ending in a point, this shape giving occasion to the name *Needle of Cybele*. It was brown in colour, and looked like a piece of lava. Arnobius, a Christian writer just before the accession of Constantine, and over five hundred years from the date of its arrival at Rome, says of the stone:

"If historians speak the truth and insert no false accounts into their records, there was brought from Phrygia, sent by King Attalus, nothing else in fact than a kind of stone, not a large one, one that could be carried in a man's hand without strain, in colour tawny and black, having prominent, irregular, angular points, a stone which we all see to-day, having a rough irregular place as the sign of a mouth, and having no prominence corresponding to the face of an image." Arnobius goes on to ask whether it was possible that this stone drove the strong enemy Hannibal out of Italy—made him who shook the Roman State, unlike himself, a craven and a coward.

Just when this stone disappeared from public view I do not know. In directing the recent excavations on the Palatine Hill, Prof. Lanciani was at first in great hopes of finding it; because it had no intrinsic value to the many spoliators of Rome, nor to the former excavators of Roman temples. But the place in which he expected to find it was absolutely empty. At a later date, however, he found in a rare volume an account of excavations made on the Palatine Hill in 1730, in which the private chapel of the Empress was found and explored. In this we perhaps have an account, and, it is to be feared, the last account of a sight of the Cybele stone. The writer says: "I am sorry that no fragment of a statue, or bas-relief, or inscription has been found in the chapel, because this absence of any positive indication prevents us from ascertaining the name of the divinity to whom the place was principally dedicated. The only object which I discovered in it was a stone nearly three feet high, conical in shape, of a deep brown colour, looking very much like a piece of lava, and ending in a sharp point. No attention was paid to it, and I know not what became of it." This description is almost identical with that given by Arnobius, and others, of the stone from Pessinus.

Another stone of meteoric origin was brought to Rome, and there for a brief period was most fantastically worshipped. This was near the beginning of the third century after Christ. It came, like the other stones of which I have spoken, from Asia. In the city of Emesa, on the banks of the Orontes, about midway between Damascus and Antioch, there was in those days a magnificent temple of the Sun. A gorgeous worship was maintained before a stone that fell from heaven, that served as the image of the Sun-god. The description of the stone is not very unlike that of the Cybele meteorite. Herodian, who probably saw it, says: "It is a large stone, rounded on the base, and gradually tapering upwards to a sharp point; it is shaped like a cone. Its colour is black, and there is a sacred tradition that it fell from heaven. They show certain small prominences and depressions in the stone, and those who see them persuade their eyes that they are seeing an image of the Sun not made by hands."

This Sun-god was named Heliogabalus, and before the altar a boy of nine years of age began to serve as priest. Such a Syrian service did not make the boy grow manly nor virtuous, and when at the age of fifteen he became emperor through the money and intrigues of his grandmother, and the murder of the Emperor Macrinus, we have for three years at Rome the view of the sorriest scrapegrace that ever sat on a throne. He assumed with the name of Antoninus also the name of his god Heliogabalus. To the great disgust of the Roman Senate and people, he brought with him from Syria the image of his god, the sacred stone, and himself continued before it his priestly service with all its fantastic forms and gesticulations. He built within the city walls a grand and beautiful temple, with a great number of altars around it; he repaired thither every morning, and sacrificed hecatombs of bulls and an infinite number of sheep, loading the altars with aromatics, and pouring out firkins of the oldest and richest wines. He himself led the choruses, and women of his own country danced with him in circles around the altars, while the whole senatorian and equestrian orders stood in a ring like the audience of a theatre.

But now he must have a wife for his god. So he broke into the apartments guarded by the vestals and carried to the palace the Trojan Palladium, or what he supposed was that object, and was intending to celebrate the nuptials of the two images. His god, however, he concluded, would not be pleased with a warlike wife like Pallas; therefore, he ordered to be brought from Carthage an ancient image of Urania, or the Moon, which had been set up by Dido when she first built old Carthage. With this image he demanded the immense treasures in her temple, and he also collected from every direction immense sums of money to furnish to the Moon a suitable marriage portion when married to the Sun.

He built another temple in the suburbs of Rome, to which the Emesa stone, the god (?) was carried in procession every year, while the populace were entertained with games, and shows, and feastings and carousings. Herodian thus describes this performance:—

"The god was brought from the city to this place in a chariot glittering with gold and precious stones, and drawn by six large white horses without the least spot, superbly harnessed with gold, and other curious trappings, reflecting a variety of colours. Antoninus himself held the reins—nor was any mortal permitted to be in the chariot; but all kept attendant around him as charioteer to the deity, while he ran backward, leading the horses, with his face to the chariot, that he might have a constant view of his god. In this manner he performed the whole procession, running backwards with the reins in his hands, and always keeping his eyes on the god, and that he might not stumble or slip (as he could not see where he went), the whole way was strewn with golden sand, and his guards ran with him and supported him on either side. The people attended the solemnity, running on each side of the way with tapers and flambeaux, and throwing down garlands and flowers as they passed. All the effigies of the other gods, the most costly ornaments and gifts of the temples, and the brilliant arms and ensigns of the imperial dignity, with all the rich furniture of the palace, helped to grace the procession. The horse and all the rest of the army marched in pomp before and after the chariot."

The reign of a foolish boy at this period of Rome's history was necessarily a short one, and at the age of eighteen the soldiers killed him and let the Roman populace have the body to drag through the city streets. The worship of the Sun-god at once ceased, and, no doubt, the stone also was thrown away. The Cybele stone, however, remained an object of public worship, since the quotation from Arnobius, which I have given, was written nearly a century later than the reign of Heliogabalus.

I propose to speak briefly of one more meteorite whose

worship has had a world-wide fame: the image of the Ephesian Artemis. This worship had its centre at Ephesus, but was widely extended along the shores of the Mediterranean. Temple after temple was built on the same site at Ephesus, each superior to the preceding, until the structure was reckoned one of the seven wonders of the world. As a temple, it became the theatre of a most elaborate religious ceremonial. As an asylum, it protected from pursuit and arrest all kinds of fugitives from justice or vengeance. As a museum, it possessed some of the finest products of Greek art, notably works of Phidias and Apelles. As a bank, it received and guarded the treasures which merchants and princes from all lands brought for safe keeping. In its own right it possessed extensive lands and large revenues. The great city of Ephesus assumed as her leading title that of *νεωκόρος*, or temple-warden of Artemis, putting his name on her coins, and in her monumental inscriptions.

The image, which was the central object in this temple, was said to have fallen from heaven. Copies of it in all sizes and forms were made of gold, of silver, of bronze, of stone and of wood, by Ephesian artificers, and were supplied by them to markets in all lands. What a lifelike picture is given us in the 19th chapter of the Acts of the Apostles, of the excited crowd of Ephesians, urged on by the silversmiths, who made for sale the silver shrines of the goddess, and who saw that their craft was in danger if men learned to regard Artemis as no real divinity, and to despise the image that fell down from the sky.

We cannot suppose that the Ephesian Artemis image of the first century was a meteorite, though we have the distinct appellation, Diipetes, fallen from the sky. But I believe that there was a meteoric stone that was the original of the Ephesian images, and it seems not at all improbable that in some one of the destructions of the temple it disappeared. Or, in the progress of time, there may have been a desire to represent the goddess in a more artistic form than the shapeless stone afforded.

Many forms of the Ephesian Artemis are still preserved, and they have, amid all their variations, a certain peculiar character in common. That common character seems to me to confirm the statement that the original image fell from heaven. This goddess is regarded, let me say, as different from the Grecian Artemis, the beautiful huntress so well known in Greek art, and I am speaking only of the images of the Ephesian Artemis.

There is one peculiarity in the outward forms of the meteorites that is characteristic of nearly all of them. I mean the moulded forms, and the depressions all over the surfaces. They are better appreciated by being seen, than by any description I can give you. They are common to meteorites of all kinds, from the most friable stone to the most compact iron. (I show you one, a stone from Iowa—also the plaster cast of another, a stone from some fall, I know not which one.) Those who have lately visited the collection in the Peabody Museum may recollect the model of an iron that fell two or three years ago in Arkansas, which displays most beautifully these depressions.

Let now an artist attempt to idealise any one of these moulded forms, and to make something like a human shape out of one of them. He must necessarily set it upright, and he must give it a head. You have then a head surmounting one of these moulded forms. Let now the convenience and the taste of the artificers of the images have some liberty to act—and we know that they did act, for we have considerable variety in these images—and a development in the conventional representation of the image is sure to follow.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE State of Pennsylvania has made a grant of 150,000 dollars to Lehigh University.

DR. RALPH STOCKMAN has been appointed to succeed the late Prof. Charteris in the chair of Materia Medica and Therapeutics in the University of Glasgow.

IT is announced that the late Dr. Matthew Hinchliffe, of Dewsbury, Yorkshire, has bequeathed about 50,000*l.*—almost the whole of his property—for purposes of higher education in Dewsbury.

IN connection with the opening of a technical day school at the Borough Polytechnic Institute next month, and the general development of the Institute, the Governors have made the following appointments:—Mr. E. T. Marsh, head-master; Dr. F. Mollwo Perkin, head of the chemistry department; Mr. G. E. Draycott, lecturer in engineering.

SENIOR county scholarships, tenable for three years, providing free tuition (up to 30*l.* a year) and a maintenance grant of 60*l.* a year, have been awarded by the Technical Education Board of the London County Council to the following candidates:—Charles Cornfield Garrard, of Finsbury Technical College, who intends to proceed to Germany for three years to study chemistry; George William Howe, of Woolwich Polytechnic, who intends to proceed to the Durham College of Science, Newcastle-upon-Tyne, to study engineering; Edith Ellen Humphrey, of Bedford College, who intends to proceed to Germany for three years to study chemistry; Frederick Edwin Whittle, an intermediate county scholar of the Central Technical College, who desires to continue his engineering studies at the college. A senior county scholarship, tenable for one year, has been awarded to William Laurence Waters, of the Central Technical College, to enable him to complete his engineering course. The following special grants have been made:—To H. C. Green, H. H. F. Hyndman and W. H. Winch, grants of 50*l.* each for the coming year, to assist them in their studies at the Universities of Oxford and Cambridge; to T. M. Lowry, A. W. Poole, and H. E. Stevenson, grants of 30*l.* each for the coming year, to assist them in their studies at the Central Technical College, St. John's College, Cambridge, and the East London Technical College, respectively.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 17.—Prof. Dewar, President, in the chair.—The following papers were read:—Molecular refraction of dissolved salts and acids, Part ii., by J. H. Gladstone and W. Hibbert. The molecular refraction of a salt in aqueous solution is sometimes greater and sometimes less than that of the same salt in the crystalline state. The authors have also made determinations of the refraction constants of various substances—hydrogen chloride, nitric acid, lithium chloride, and ferric chloride—in water and organic solvents.—On a space formula for benzene, by J. N. Collie. The author has devised a new space formula for benzene in which the six hydrogen atoms are divided into two sets of three each, one set being situated inside the molecule, whilst the other set is on the outside.—On the production of some nitro- and amido-oxypicolines, by A. Lapworth and J. N. Collie. Dioxypicoline, $C_6H_7NO_2$, is readily nitrated, yielding a nitrodioxypicoline, $C_6H_6N_2O_4$; this, on reduction, yields an amidodioxypicoline $C_6H_8N_2O_2$, which is easily hydrolysed with formation of a trioxypicoline, $C_6H_7NO_3$.—Further experiments on the absorption of moisture by deliquescent substances, by H. W. Hake. From experiments made on a number of deliquescent substances the author concludes that during deliquescence a quantity of water corresponding to a definite hydrate is taken up.—The fusing point, boiling point and specific gravity of nitrobenzene, by R. J. Friswell. In view of the discordant values given by various authors for the above constants, the author has re-determined the physical constants of both solid and liquid nitrobenzene.—The action of light on a solution of nitrobenzene in concentrated sulphuric acid, by R. J. Friswell. A solution of nitrobenzene in concentrated sulphuric acid is very rapidly blackened by exposure to sunlight or burning magnesium ribbon.—The reduction of perthiocyanic acid, by F. D. Chattaway and H. P. Stevens. The reduction of perthiocyanic acid by tin and hydrochloric acid gives an almost quantitative yield of thiourea and carbon bisulphide in accordance with the equation:—$H_2N_2C_2S_3 + 2H = CS(NH_2)_2 + CS_2$.—The so-called hydrates of isopropyl alcohol, by T. E. Thorpe. The author has been unable to find any experimental evidence in favour of the existence of the four hydrates of isopropyl alcohol which have been described.—The carbohydrates of cereal straws, by C. F. Cross, E. F. Bevan and C. Smith.—Studies on the constitution of tri-derivatives of naphthalene. No. 16. Conversion of chloronaphthalenedisulphonic acids into dichloronaphthalenesulphonic acids, by H. E. Armstrong and W. P. Wynne. The authors find that the conversion of naphthalenesul-

phonic acids into chloronaphthalenes by heating with phosphorus pentachloride may be thoroughly trusted as a means of determining constitution in the naphthalene series, inasmuch as no isomeric change occurs. The chloronaphthalenedisulphonic chlorides when heated with phosphorus pentachloride are converted partly into dichloronaphthalenesulphonic chlorides and partly into trichloronaphthalenes of the same orientation.—Conversion of 1 : 1'- into 1 : 4'-dichloronaphthalene by hydrogen chloride. The products of hydrolysis of 1 : 1'-dichloronaphthalene-3-sulphonic acid, by H. E. Armstrong and W. P. Wynne.—Note on the formation of diacetanilide, by G. Young. Acetanilide is readily converted into diacetanilide by boiling with excess of acetic chloride.—Derivatives of phenetol azophenols, by J. T. Hewitt, T. S. Moore and A. E. Pitt. In order to obtain further information respecting the remarkable coloured derivatives of benzeneazophenol, the authors have prepared and examined the ortho- and para-phenetolazophenols and their derivatives.—δ-Ketopinic acid and camphoic acid, by W. S. Gilles and F. F. Renwick. The inactive δ-ketopinic acid obtained by oxidising active pinene hydrichloride can be separated into two optical antipodes by crystallising its strychnine salts; the tribasic acid obtained by oxidising ketopinic acid is camphoic acid.—Note on stereoisomeric di-derivatives of camphor and on nitrocamphor, by T. M. Lowry. On brominating chlorocamphor, or chlorinating bromocamphor, products are obtained which seem to be isomorphous mixtures of the stereoisomeric αα-chlorobromocamphors.—

$$C_8H_{14}<\begin{matrix} C<^{Cl}_{Br} \\ | \\ CO \end{matrix} \quad \text{and} \quad C_8H_{14}<\begin{matrix} C<^{Br}_{Cl} \\ | \\ CO \end{matrix}.$$

Nitrocamphor is birotatory in benzene solution; when its benzene solution is evaporated and the residue heated on the water bath, a substance is obtained which differs widely in physical properties from nitrocamphor.—The interaction of ethylene dichloride and ethylic sodiomalonate, by B. Lean and F. H. Lees.—Hexanaphthene and its derivatives. Preliminary note, by Miss E. C. Fortey.

PARIS.

Academy of Sciences, August 2.—M. Wolf in the chair.—On the commencement of the combination between hydrogen and oxygen, by M. Berthelot. The temperature at which hydrogen and oxygen begin to combine has been the subject of numerous researches; but widely differing results have been obtained, even by the same observers, in attempting to repeat an experiment under apparently precisely similar conditions. These differences are undoubtedly due to secondary reactions, and the present paper is devoted to the elucidation of some of these. In presence of baryta, the gases completely combine at 280° in twenty-six hours. The reaction, however, is a complex one, since if the experiment is stopped after five hours, barium peroxide is found to be present. With caustic potash analogous phenomena were observed.—On the analysis of aluminium and its alloys, by M. Henri Moissan. An examination of the methods of analysis of aluminium, proposed by M. Balland, has shown that the gain in speed is accompanied with a loss in accuracy. The original method proposed by the author, although tedious, is necessary for trustworthy results.—On the fixation and nitrification of nitrogen in arable earths, by M. P. P. Dehérain.—The toxic effects produced by the sweat of a healthy man, by M. S. Arloing. It is shown that perspiration contains substances of considerable toxic power, the properties of which possess some analogy with some of the microbial toxines.—On the symmetrical tetramethyldiamidodiphenyldianthranoltetramethyldiamide from the corresponding oxanthranol, by MM. A. Haller and Guyot. The formation of this substance is easily effected by the use of phosphorus oxychloride as a condensing agent, although the previous attempt of O. Fischer with sulphuric acid failed.—Occultation of the group of the Pleiades by the moon, July 23, 1897, at Lyons, by M. Ch. André.—On isothermal surfaces, by M. A. Pellet.—Light apparatus for the rapid determination of the acceleration due to gravity, by M. Marcel Brillouin. A short pendulum beating quarter seconds was used, together with a chronometer the escapement of which was so modified as to furnish flashes of light at known intervals apart.—On permanent changes of shape undergone by glass, and on the displacement of the zero of thermometers, by M. L. Marchis.—On the compressibility of gases in the neighbourhood of the atmospheric pressure, by MM. A. Leduc and P. Sacerdote.—On the atomic weights of nitrogen, chlorine and silver, by M. A. Leduc.—Thermochemical determinations relating to cupric compounds, by M. Paul Sabatier.—On some bromoketones, by M. A. Collet.—Observations on the combination of some diazo-compounds with phenols, by MM. Ch. Gassmann and Henry George.—On caroubinose, by M. Jean Effront.—On an organic compound rich in manganese extracted from ligneous tissue, by M. G. Guérin. The substance in question contained 0·4 per cent. of manganese.—Presence of iodine in parathyroid glandules, by M. E. Gley. The glandules are small bodies attached to the thyroid gland proper of the rabbit. The percentage of iodine is much larger in the former than in the latter.—The eparterial bronchia in the Mammifera, and especially in Man, by M. D. A. d'Hardivillier. — The first stages in the development of the Pedipalps, by Mdlle. Sophie Pereyaslawzewa. — Sympathetic nervous system of the Orthoptera, by M. L. Bordas. —On a new Sporozoa (*Cœlosporidium chydoricola*) intermediate between the Sarcosporidia and the *Amœbidium* (Cienkowsky), by MM. Félix Mesnil and Émile Marchoux.—Phagocytic organs observed in some marine annelids, by Dr. J. Cantacuzène.—Experimental study of the Coccidia, by M. Louis Léger.—On the independence of certain bundles in the flower, by M. Paul Grélot.—Reflex functional troubles of peritoneal origin, observed during the evisceration of deeply anæsthesised animals, by MM. L. Guinard and L. Tixier.—On the diamond-bearing rocks of the Cape and their variations in depth, by M. L. De Launay.—On the probable antiquity of tin mining in Brittany, by M. L. Davy. The tin mines in Brittany would appear to have been used by the Gauls prior to the Roman Conquest.—On the action of high frequency currents from the point of view of arterial tension, by M. A. Montier.—On a palliative electrical treatment of facial neuralgia, by M. J. Bergonié.

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THURSDAY, AUGUST 19, 1897.

THE STORY OF AN INDIAN PROVINCE.

The North-Western Provinces of India. By W. Crooke, B.C.S. (retired). Pp. 361. (London: Methuen and Co., 1897.)

THIS book professes to be "an attempt to tell the story of one of the greatest of our Indian Provinces from the social point of view"; and no one who reads it will deny that the attempt has been completely successful. The author has had vast experience as an Indian official; he is well known as an authority on Indian religions and folk-lore (see the review in NATURE, April 22, 1897, of his work on "The Popular Religion and Folk-Lore of Northern India"), and, as Superintendent of the Ethnographical Survey of the N.W.P., he has had unique opportunities of studying the life and customs of the people. Lastly, he possesses the enviable faculty of being able to express the results of tedious and painstaking observations in a most readable form. In fact, we have here, in a nutshell, an amount of information which could only be obtained otherwise either by a similar experience or by a diligent study of many ponderous Blue-books. The style is easy and pleasant, and possesses no small merit from the literary point of view. The keen intelligent interest of the writer in his subject communicates itself to the reader, while his sympathy with the beauties of nature gives to the book something of the charm which characterises Bishop Heber's diary.

At the present time, especially, Mr. Crooke's work will be welcome as affording information on those serious questions which have of late excited an unusual degree of interest. Now that famine, plague, and, in some degree, disaffection, are taxing the resources of British administration, it is well to know what steps have been taken in times past to meet similar dangers and difficulties; and it is not too much to say that little doubt will be left in the impartial reader's mind that, whatever may have been the shortcomings of British rule, it has at least accumulated a vast store of knowledge and experience which enables it to cope, with a great degree of success, with calamities the effects of which would, in bygone ages, have been appalling beyond measure. And it must not be forgotten that, in India, there are many causes which combine to make progress not only slow and uncertain, but even sometimes dangerous. To take, for example, one of the difficulties which the ultra-conservative instinct of the people places in the way of the prevention of famine. Elsewhere the natural relief of a congested population is afforded by emigration, but—

"This people, again, definitely refuses to avail itself of that relief by emigration to less congested areas, which led the surplus population of Ireland to the American continent, and is now driving Italians to Brazil or Argentina, and the Chinaman to the Malay Peninsula and the islands of the Southern Sea. The State is thus here confronted with a problem which would tax the resources of the greatest governments. There is, perhaps, no more pathetic situation in the whole range of human history than to watch these dull, patient masses stumbling in their traditional way along a path which can lead only to suffering, most of them careless of the future, marrying and giving in marriage, fresh generations ever encroaching on the narrow margin which separates them from destitution."

Even greater obstacles to reform are those due to religious or social causes. Sanitary reform, for instance, must necessarily interfere with habits and customs all of which are sanctioned by a long tradition, and some of which are actually regarded as sacred.

"The progress made in sanitation during the last thirty years serves only to emphasise the fact that the task is of stupendous difficulty, that much of it is beyond the power of any Government to undertake unless it throws to the winds all considerations of finance and all regard for the prejudices of the people. . . . The constant crusade carried on to enforce some degree of cleanliness among the town population has undoubtedly been to some extent effective. . . . But as for a general crusade against filth in rural India the people will not endure it, and no Government in its senses would seriously propose to wage it."

Of course, if sanitation is not to be enforced, and if over-crowding is not to be prevented, how can plague be averted? And, as has been seen quite recently, the means of stamping out plague cannot be put into practice without grave risk of exciting the religious or caste susceptibilities of the people.

Some curious results come from the application of Western ideas to Eastern circumstances. We accept as fundamental axioms of law and justice the doctrines of the equality of all men in the eye of the law, and of the binding force of contracts legally made; and it is not imaginable that English government could prevail anywhere apart from these axioms. But it cannot be denied that rigid adherence to them has brought, and must necessarily bring, not only unpopularity to the Government, but also serious economic troubles to the people themselves. The first cause has, by completely upsetting all their ideas of the distinctions of caste, made British rule extremely distasteful to the nobility and higher classes generally.

"They disapprove of the cold impartiality of our law, which has abolished the traditional distinction between the gentleman and the menial, and makes it possible for the serf to drag the Rāja before one of our courts."

The second cause has results far more serious. We have had some instances recently in England of the power which the law, by enforcing the terms of a legal contract, gives to the usurer over his victim. But this abuse is in India carried to an extent of which we can have no conception.

"It is, in the opinion of the most competent authorities, not an exaggeration to say that three-fourths of the tenantry are indebted to the amount of a year's rent at least."

And the remedy for this terrible state of affairs, in which the most worthy portion of the community is surely being brought under the power of the least worthy? That is the problem which for many years has exercised, and is now exercising, many anxious minds, for on its solution the future prosperity of a great portion of India depends. Expedients innumerable have been suggested, and some of these cures have made the disease worse.

"We ourselves did try a form of usury law, but with the natural result. It was evaded wholesale by necessitous debtors, and the simple device was adopted of tacking on the prohibited interest to the original loan. . . . A native ruler of the old type would probably begin by putting half a score of usurers to death by slow torture; but this is not our way, nor would it in this case do much good except to check money-lending for a season. We are on the horns of a dilemma. We believe in the sanctity of contract, but we loathe Shylock, and writhe at seeing the peasant come shorn out of his clutches."

As an interesting and clear account of these and innumerable other questions affecting the welfare of the people, Mr. Crooke's book is greatly to be commended. The stay-at-home Englishman is, and always has been, inclined to lay down some system of theoretical perfection for the government of our great Eastern dependency. He will learn here that there are too many causes of friction—the opposing interests and prejudices of different religions, different races, and different castes—to admit of any perfectly smooth working of the great machine of Government. For the sake of peace and practical expediency it is necessary to yield a little here and a little there, and to moderate the rate of progress to suit the conditions of the case.

A really weak point in an otherwise altogether admirable work is that portion of Chapter ii. which deals with the history of the province from the earliest times down to the Muhammadan conquest. Mr. Crooke has not consulted the latest authorities on this subject; and in not doing so, he has made a mistake which is all the more serious because, as it happens, the study of inscriptions and coins has, within the last few years only, brought to light a very considerable amount of historical information. Very few of the dates for the earliest period given by Mr. Crooke are accepted by scholars nowadays. The initial year of the Gupta era is, for instance, no longer regarded by any one as lying between the years 160 and 170 A.D. For this statement Mr. Crooke quotes Mr. Vincent Smith: "the most recent authority on the gold coinage of the Guptas." Mr. Vincent Smith is still entitled to this designation; but, between the date of the work to which Mr. Crooke refers and the date of publication of Mr. Crooke's book, he has contributed a number of articles to learned periodicals, in which he has accepted the years 319-20 A.D. as the starting-point of the Gupta era Again, a great deal more is known now about the different Scythic invasions of Northern India and their dates than would be inferred from Mr. Crooke's account. In a word, this portion of the book—unimportant though it may be from the author's point of view—is altogether unsatisfactory, and should be entirely rewritten in a new edition.

It remains only to notice that the work is admirably printed, bound, and illustrated.

CHEMICAL EQUILIBRIUM.

The Phase Rule. By Wilder D. Bancroft. Pp. viii + 255. (*The Journal of Physical Chemistry*, Ithaca, New York, 1897.)

IN the preface to this book the author says:—

"My idea is that all qualitative experimental data (referring to chemical equilibrium) should be presented as particular applications of the Phase Rule and the Theorem of Le Chatelier, while the guiding principles for the classification of quantitative phenomena should be the Mass Law and the Theorem of van 't Hoff. In this book I have tried to present the subject of qualitative equilibrium from the point of view of the Phase Rule and of the Theorem of Le Chatelier, without the use of mathematics."

Notwithstanding the thoroughness with which this programme has, on the whole, been carried out, the writer cannot help feeling that the result is not completely satisfactory, and that this is largely due to the narrow treatment rendered necessary by the limitations which the author has imposed on himself. The phase rule itself merely gives the connection between the number of components of a system, the number of phases, and the number of external factors of equilibrium (pressure and temperature usually) on the one hand, and the number of independently variable factors of equilibrium on the other. It gives no further information about the system whatever. The theorem of Le Chatelier permits us to predict the direction in which the equilibrium will be displaced by a change in one of the factors of equilibrium. A study of chemical equilibrium from this limited point of view, almost of necessity resolves itself into an enumeration of the different possible cases (as, for example, a system containing one component and one phase, which may be liquid, solid, or gaseous; a system containing one component and two phases, and so on, considering in turn systems containing two, three, or more components), together with a description of the special cases which have been investigated, in so far as they illustrate the two guiding principles above mentioned. This is, on the whole, the plan adopted by the author, and his discussion of many possible cases of which no actual example has been investigated, will be of much service in indicating profitable lines for research.

The equilibria between solids and solutions, and between two solutions are very fully treated; whilst the dissociation of calcium carbonate and of ammonium chloride are the only ones of their kind mentioned, equilibria in homogeneous gaseous or liquid systems are omitted, and the metallic alloys receive somewhat scanty attention. Some of these omissions are doubtless due to the fact that the study of the cases in question is not materially assisted by the application of the phase rule.

The distinction which is made between solvent and dissolved substance (for which latter the author adopts the not very euphonious term "solute") appears to the writer to be purely conventional, and not, as Prof. Bancroft seems to think, a real difference. On pp. 36 and 37 we read:—

"In cases of limited miscibility there is no difficulty in telling which component is solvent and which solute; but when the two substances are consolute (miscible in all proportions), there is at present no sure way of deciding at what concentration the change takes place."

The introduction of a conception which is incapable of more accurate definition than the foregoing, can and does only obscure the subject. The distinction of solubility from fusion curves and the consequent differentiation of eutectic alloys from cryohydrates, seems to the writer to be unnecessary and undesirable. On p. 127 there is

a curious discussion as to whether liquids which are miscible in all proportions are, or are not, mutually infinitely soluble. A clear definition of solubility, which is nowhere to be found in the book, would have made this impossible.

A little more care bestowed on the literary workmanship of the book would have made it much more attractive, and saved the reader both time and trouble. For example, he is left to guess what quantities are taken as ordinates and abscissæ of several of the curves; frequently, also, a curve is referred to without any indication of the diagram on which it is to be found; this is perplexing when, as on p. 49, the diagram is finally discovered eleven pages further back. The English, too, is not always above reproach. On p. 51 we read, for example: "If instead of diminishing the pressure upon a saturated solution reaching the divariant system, solid solute and vapour, we increase it," &c. Abrupt, not to say discourteous, criticism, such as the following (from p. 158), is also to be deprecated in a serious scientific work:—

"Étard has stated that the line O F terminates at the melting point of the more fusible salt. This is entirely wrong. The curve O F terminates at the temperature of the eutectic alloy formed from the two salts, a temperature which is necessarily lower than the melting point of potassium nitrate. Curiously enough, Étard has an inkling of the truth in one case, but it is not sufficient to make him modify his erroneous hypothesis."

The writer would not have dwelt on these comparatively trivial faults at such length were it not that the book contains much that is valuable. The numerous references to the newer work on the subject (and that is by far the greater part of it) will be of great service to any one desiring to make a more profound study of the problems of heterogeneous equilibrium. T. E.

EAST INDIAN BEES AND WASPS.

The Fauna of British India, including Ceylon and Burma. Edited by W. T. Blanford, F.R.S. (Published under the authority of the Secretary of State for India in Council.)

Hymenoptera. Vol. i. Wasps and Bees. By Lieut.-Colonel C. T. Bingham. 8vo. Pp. xxix + 579; 188 woodcuts, 4 coloured plates. (London: Taylor and Francis, 1897.)

THE first of the volumes before us is one of a series that is being produced under the authority of the Secretary of State for India, in order to diffuse knowledge already obtained and to facilitate the acquisition of further information. The book is the twelfth volume of the series, which was commenced in 1888 by the issue of a volume on the Mammals, written by Dr. W. T. Blanford, F.R.S., who is also the editor of the series. The entomology of India has been hitherto too much neglected, and the literature is very scattered and fragmentary; indeed, until quite recently it has not been possible to ascertain even the names of the locusts that from time to time devastate various parts of India. Our thanks are therefore due to those who are endeavouring to remedy this state of affairs. Four volumes on Lepidoptera have already appeared in the series. Though butterflies and moths are the special favourites of the Insect world with British entomologists, they are by no means the most important insects either from a scientific or an economic point of view, and the editor of the series has done well to break fresh ground with this volume on the bees and wasps, even though it cannot be expected that the work shall prove an exhaustive one. We are glad to find that the venture is a successful one, especially as very serious difficulties, arising from the incompleteness of collections of these insects and their inadequate nomenclature, have had to be encountered.

Colonel Bingham, the author of the second volume under notice, has an extensive acquaintance with the insects he describes, gained during many years of work as Conservator of Forests in India. The volume does not include the ants and the ruby-flies, but, with these exceptions, comprises the most important of the Hymenoptera, and includes just about 1000 species. It is chiefly devoted to descriptions and to tables by which the names of the species may be ascertained. As this work will necessarily be, for some time to come, the standard one on the aculeate Hymenoptera of India, it was necessary that nomenclature and classification should be thoroughly dealt with. These points are satisfactory, the descriptions being concise and clear, and the classification and nomenclature up to the level of the best and latest work. Now that the naturalists of India have this valuable volume to aid them in the preliminary work of finding out the names of the stinging Hymenoptera they meet with, we may hope that attention may be given to their habits and instincts. The fossorial Hymenoptera occupy considerably more than half the present volume; their habits are varied in details and of extreme interest, so that a large field is here opened to the observing naturalist. The fact that these insects are many of them able to sting the victims they carry off and store as food for their young, in a manner that would be creditable even if they had a perfect knowledge of anatomy, is now, thanks to the labours of Fabre and others, generally known.

It is not, however, known to more than a few that in one group of Fossors—the Ampulicides—the members have the still more inexplicable power of merely taking their prisoners captives, and making them march to the spot where they are to be immured and eaten. Colonel Bingham tells us that "these beautiful insects are predatory on cockroaches. In Burma I have frequently seen these wasps come into the house and search for their prey under boxes and furniture. In the forest once I watched a rather large specimen of *A. compressa*, Fabr., struggling with a huge cockroach; the latter was either paralysed by a sting, or dazed with fear, and was being half dragged by an antenna and foreleg, half hustled and pushed along by the active little wasp."

Although the number of species in this volume (about 1000, as we have previously stated) may appear to those unacquainted with entomology to be large, yet the volume in this respect is probably far from complete. Indeed, it is not improbable that the aculeate Hymenoptera of India will be found to number 2000 species; and now that this volume is available for the assistance

of investigators, we may trust that the museums and naturalists of India will avail themselves of it in order to advance the subject by serious work, and thus render a second edition necessary. We may point out that in such case it would be well, in the bibliographical references, to distinguish those that relate to habits and biology from those that are systematic and nomenclatorial. D. S.

OUR BOOK SHELF.

A Contribution to the History of the Respiration of Man. By William Marcet, M.D., F.R.C.P., F.R.S. Pp. 116; charts and diagrams. (London: J. and A. Churchill, 1897.)

THE book before us comprises the subject-matter of the Croonian lectures delivered before the Royal College of Physicians in 1895, and an appendix, which latter contains a full description of the methods of investigation employed by the author. The first lecture contains a discussion of respiration from a general biological standpoint, and concludes by giving the effects of muscular exercise upon the production of CO_2, and the temperature of the body. The second lecture is devoted to human respiration; the different forms of breathing, and the absorption of oxygen in the body are considered in it. In the third lecture the effect of volition upon respiration is discussed, simple volition towards any kind of muscular exercise, *i.e.* volition without any response being attended by an increased production of CO_2, and an increased absorption of O. The question to what extent response to volition can be checked is, with regard to the author's deductions, of the greatest importance. In any case the volition exerted is not simple volition to increased breathing or muscular movement, but volition to the movement in question + volitional inhibition of the movement. The results of the author in this direction will almost certainly attract the attention of psychologists. In the fourth lecture the author discusses the changes in respiration produced by changes in the pressure of the atmosphere breathed, and concludes by showing the influence low atmospheric pressure exerts in checking volition. The appendix comprises a description of the methods used, and numerous experimental protocols.

The book must be regarded as a valuable contribution to the physiology of man. It is to be regretted that no general index, and no headings to the chapters are given. The summaries at p. 70 in the text could have been placed to much greater advantage at the head of their respective chapters. It is to be hoped that the sphere of usefulness of the book will not be curtailed by this omission. F. W. T.

Untersuchungen ueber den Bau der Cyanophycien und Bacterien. Von Prof. Dr. Alfred Fischer. Mit 3 lith. Tafeln. (Jena: verlag von G. Fischer, 1897.)

THE author gives a critical and literary account of the structure of the cells of bacteria and of the blue-green algæ, which possess many features in common. He comes to the conclusion, in opposition to many other investigators, that no real nucleus, or nucleus-like body is really present, but he considers that the colour of the algæ is to be regarded as localised in a chromatophore.

A great part of the book is devoted to an account of the methods in vogue in connection with researches into these minute histological details, and Dr. Fischer's criticisms will be read with interest by all who remember the fine work he has already done, especially in elucidating the structure of bacteria.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Brilliant Perseid.

IN the hope of being able to record photographically the passage through our atmosphere of some of the August meteors, I exposed during the night of August 12 three photographic plates, one towards the pole star, and the other two towards the constellations of Perseus and Lyra. On the plate exposed to the latter constellation absolutely no trace of any meteor trail can be seen, but on the other two a very definite and distinct trail, peculiar for the different degrees of condensation in it, is easily visible. From the position and similarity of the trail on the two plates, there is no doubt that the same meteor was in question. These two plates were exposed in cameras, one a 5 × 4 with a Zeiss double combination lens of 224 millimetres focal length, and the other a 7½ × 5 with a Dallmeyer rapid rectilinear lens. The trail recorded by the latter instrument falls so near the edge of the plate that the image is somewhat out of focus; but on the other plate, although it is also near the edge, the image is very sharp and clear. From an examination of this plate, the following particulars have been obtained:—The path of the meteor extends nearly 9° in the constellation of Camelopardus, and a comparison with Cottam's star chart shows that the coordinates of the points of appearance and disappearance were, according to the photographic plate, R.A. 4h. 53m. Decl. + 65° 25', and R.A. 5h. 32m. Decl. + 66° 15'. The actual visible length of trail must have been much longer than this, although the lens and plates used were both very rapid. It may be mentioned that the most dense part of the trail was equal in intensity to that given by the image of β Camelopardus (4th mag.) after an exposure of fifty-five minutes (11.20 p.m. to 12.15 a.m.).

The trail commences by being very faint, gradually increasing in density; it then fades off a little, and again becomes more dense for a short period of time. After another interval it becomes very dense, corresponding in this respect with the image of β Camelopardus. Again it becomes feeble for some distance on the plate with one minor condensation, and then suddenly there is an abrupt increase in density, after which it gradually fades away, and is no longer visible.

The path traversed lay nearly half-way between the stars 739 and 780, and passes a little to the south of α Camelopardus. The meteor was evidently a true Perseid, the trail, when produced backwards, lying slightly to the south of η Persei.

In conclusion, it may be added that the camera was set so that η Persei should fall in the centre of the plate, the instrument being mounted on the object-glass end of the Kensington 10-inch equatorial. The exposure lasted from 11h. 20m. p.m. to 12h. 15m. a.m. W. J. S. LOCKYER.

X-Ray Tubes.

THESE tubes when very highly exhausted become capricious; at times they will do good work, while at other times, and without any known cause, they refuse to illuminate.

In my endeavour to learn by experiment, I found that when playing the electricity upon and round the outer surface of the kathode end of the tube, it is quite possible to obtain sparks between the kathode wire and the inner surface of the glass. With each such spark the otherwise obstinate tube is momentarily illuminated; evidently the spark is owing to charges induced on the inner surfaces of the tube.

This led me to coat the kathode end of the tube with tinfoil, leaving about a ¼-inch gap between the tinfoil and the kathode terminal of the tube; the behaviour of the tube is now much affected—formerly it was uncertain when used with a 6-inch spark-length—and required frequently heating. With the tinfoil coating the tubes illuminate with certainty and with a much shorter spark-length. In fact I can now easily, and well, illuminate a highly-exhausted tube with an influence machine which has 17-inch plates. JAMES WIMSHURST.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

IV.

THE programme of work to be attempted in the Indian eclipse of next year, referred to in the last article, carries me back very vividly to the eclipse of 1871, also observed in India. The shadow path of the eclipse of that year also cut the west coast of India, but at a much more southerly point than Viziadurg. The coast station was then Baikal, and from this point the shadow swept over the land in a south-east direction, as shown in the accompanying map (Fig. 13).

The retrospect is very encouraging, for one is reminded of the enormous advance in our knowledge of the sun since that time; and more than this, we have now the supreme advantage that eye observations have been almost entirely superseded by permanent photographic records. The accompanying view (Fig. 14) of my observatory at Baikal in 1871 will show that eye observations of the spectra alone were attempted.

It must also be remembered that none of the laboratory experiments, referred to in the last article, had then been made.

Now it was to try to understand such hard solar facts as those referred to in the last article, facts since observed carefully in all their detail, month after month and year after year, that much of my early experimental work was undertaken.

By 1872 the influence of quantity or density had been made out; when experiments were made at one temperature the spectrum got simpler as the quantity was reduced, so that the spectrum was finally reduced to its longest line.[1]

I am glad to see that Sir William Huggins, who appears to be ignorant of my quarter-of-a-century-old work, has quite recently arrived independently at the same conclusions.

Next came the influence of temperature. This was a much more difficult problem to tackle, for the reason that enormous changes in the spectrum of each chemical substance were brought about by changing the temperature conditions; but finally the association of certain lines with certain temperatures was accepted by everybody, though as to the *why* there were and are contending schools of opinion.

In connection with certain stellar problems awaiting solution, I have recently been compelled to return to this question, and I have used a more powerful current and larger jar-surface than that I formerly employed; and, further, the recent work carries the results into the photographic region. The result is important, since the old results have been confirmed and extended. To deal with the case of iron, seven additional lines in the spectrum have been found to have their brightness enhanced at the highest temperature.

These, as well as the two previously observed, are shown in the following table, which also indicates the behaviour

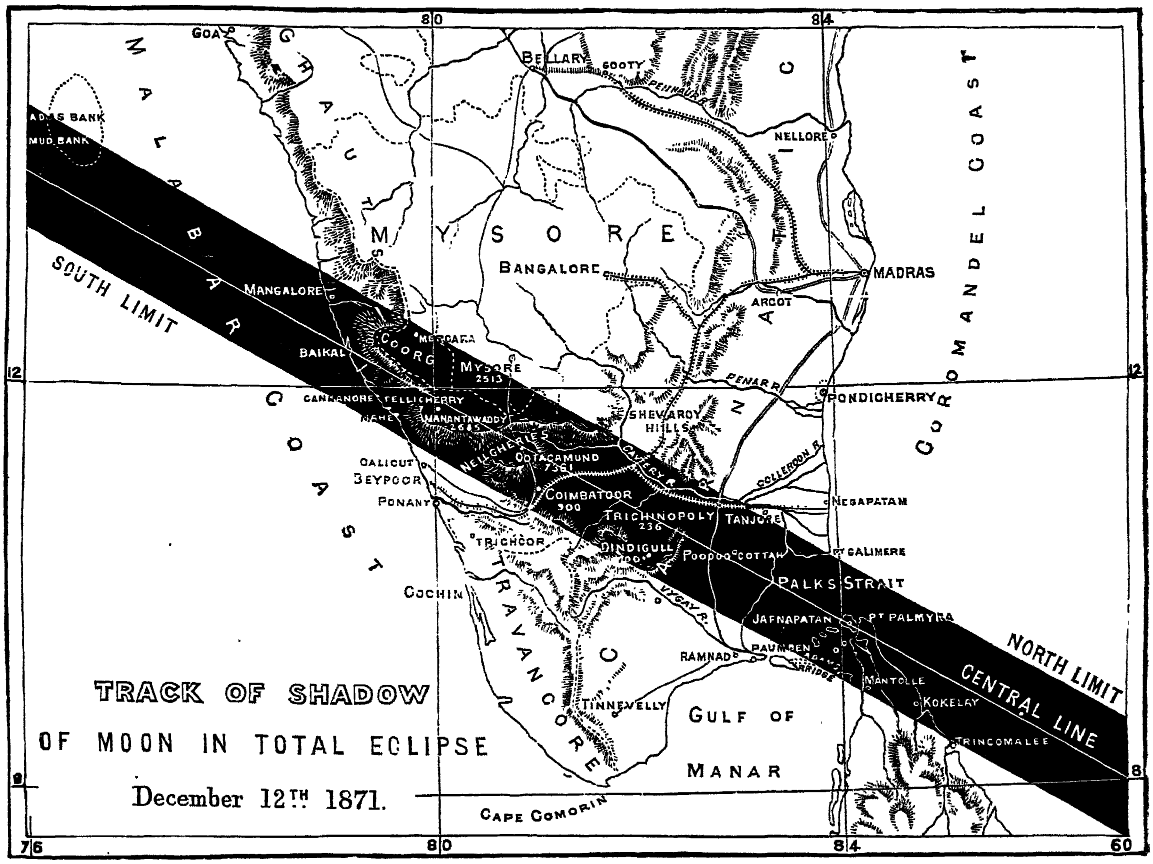

FIG. 13.

1 Continued from page 321.

1 *Phil. Trans.*, 1873, pp. 253 and 639.

of the lines under different conditions, as observed by Kayser and Runge (K. and R.) and myself (L.) in the arc, and by Thalèn (T.) and myself in sparks :—

Lines of Iron which are enhanced in Spark.

Wave-length.	Intensity in flame.	Intensity in arc (K and R) Max. = 10.	Length in arc (L). Max. = 10.	Intensity in spark (T). Max. = 10.	Intensity in hot spark (L). Max. = 10.
4233·3	—	1	—	—	4
4508·5	—	1	—	—	4
4515·5	—	1	—	—	4
4520·4	—	1	—	—	2
4522·8	—	1	3	—	4
4549·6	—	4	5	—	6
4584·0	—	2	4	—	7
4924·1	—	1	3	6	6
5018·6	—	4	—	—	6

hottest stars are shown in the diagram on p. 368, and for the sake of comparison, the behaviour of a group of three lines, which are among the most marked at lower temperatures, is also indicated. In addition, the diagram shows the inversion in intensities of the spark and arc lines in the spectrum of a relatively cool star—such as α Orionis (Fig. 16).

The facts illustrated by the diagram indicate that the enhanced lines may be absent from the spectrum of a star, either on account of too low or too high a temperature. In the case of low temperature, however, iron is represented among the lines in the spectrum, but at the highest temperature all visible indications of its presence seem to have vanished.

This result affords a valuable confirmation of my view, that the arc spectrum of the metallic elements is produced by molecules of different complexities, and it also indicates that the temperature of the hottest stars is sufficient to produce simplifications beyond those which have so far been produced in our laboratories.

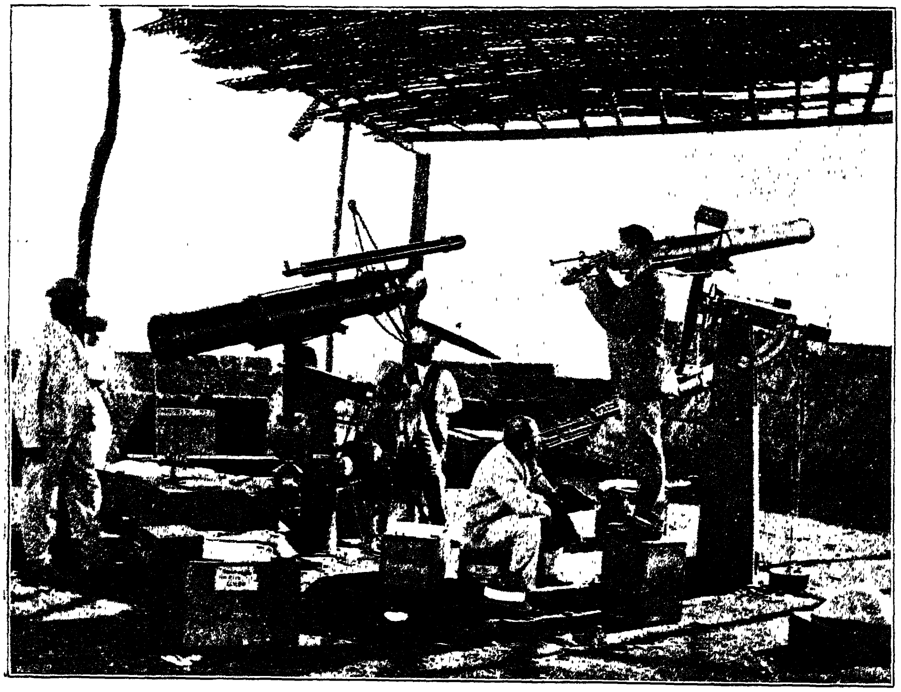

FIG. 14.—The spectroscope observatory at Baikal in 1871.

Combining this with former results, we seem justified in concluding that, in a space heated to the temperature of the hottest spark, and shielded from a lower temperature, these lines would constitute the spectrum of iron.

To enforce what I have previously written concerning the value of the solar work in relation to the study of the physics and chemistry of the stars, it is worth while to consider for a moment the behaviour of these lines of iron which are found to brighten as the temperature is increased and which play such an important part in the chromosphere spectrum, in stellar spectra (Fig. 15).

Defining the hottest stars as those in which the ultra-violet spectrum is most extended, it is known that absorption is indicated by few lines only. In these stars iron is practically represented by the enhanced lines alone; those which build up, for the most part, the arc spectrum are almost or entirely absent.

The intensities of the enhanced lines in some of the

We may say broadly that the stars Bellatrix, α Cygni, and Arcturus represent three very different stages of star life from the point of view we are considering.

In Bellatrix the metallic lines, both enhanced and cool, are almost entirely absent. In α Cygni we get the enhanced metallic lines alone; in Arcturus they are generally absent; this statement is true for the sun, the spectrum of which is almost identical with that of Arcturus.

Now it has been found from the study of the photographs of the chromosphere obtained in 1893 and 1896, that among the bright lines recorded the enhanced lines hold a most important place. I have already given copies of two of the photographs obtained in 1893. I can now add untouched copies of an enlargement of one of the photographs obtained in 1896, which has quite recently been published by the Royal Society. The photograph was obtained by Mr. Shackleton, attached

to Sir George Baden Powell's expedition to Novaya Zemlya (Figs. 17, 18).

So far as the work has gone, the comparison of the enhanced lines with the spectrum of the chromosphere reveals several facts of importance. In the case of iron, I have already pointed out (*Roy. Soc. Proc.*, vol. lx. p. 475) that the enhanced lines were all present in the chromosphere during the eclipse of 1896, and most of them in that of 1893, their intensities being greater than those of the corresponding Fraunhofer lines. Many of the characteristic arc lines of iron also appear in the chromosphere, but the presence of the enhanced lines with such great intensities indicates that at least in some parts of the chromosphere the temperature of the iron vapour is considerably higher than that of the iron vapour which is most effective in producing the Fraunhofer lines. A

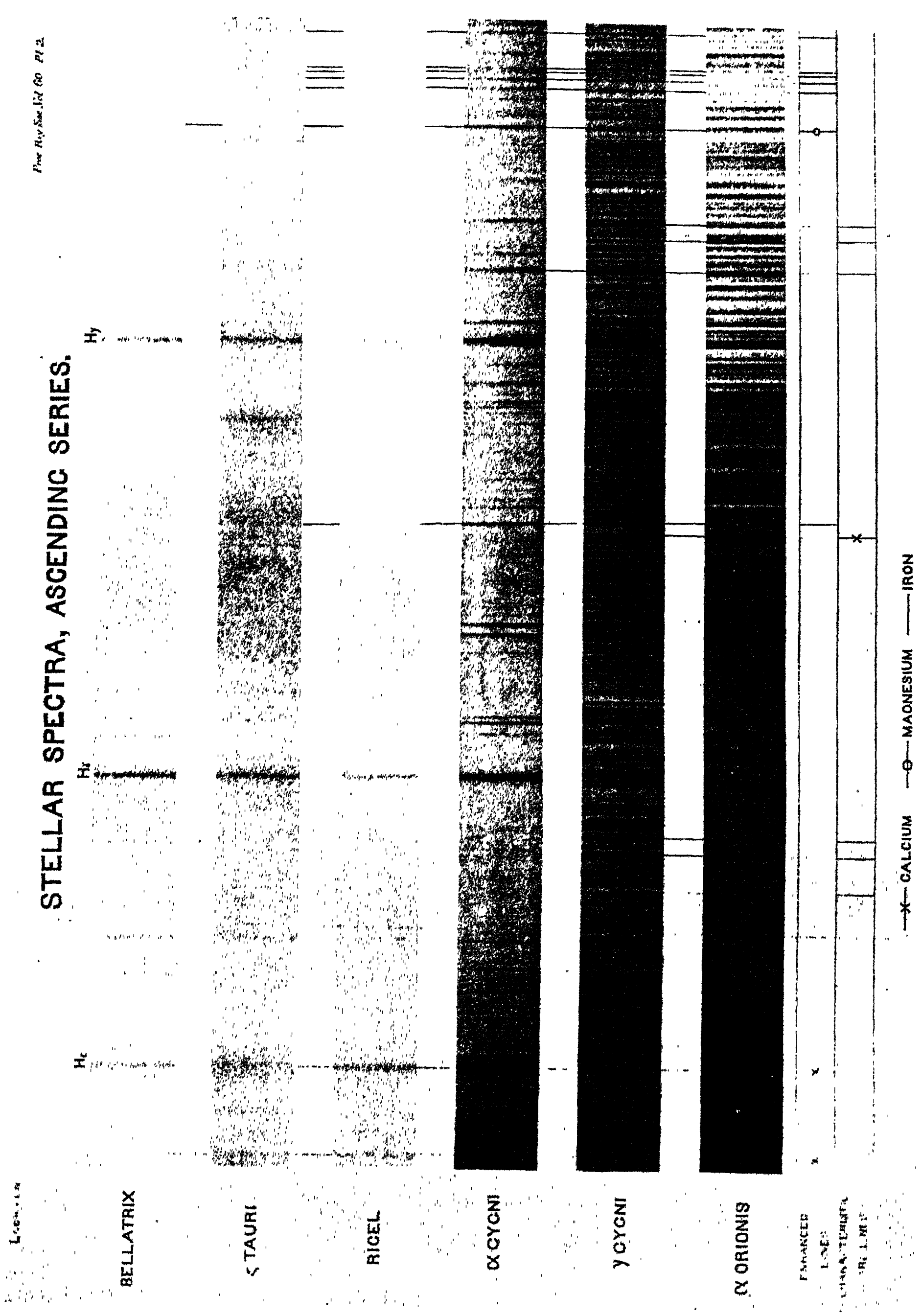

FIG. 15.—Map showing cool and enhanced lines of iron, and their behaviour in stellar spectra.

similar result is obtained when other substances are considered. The special importance of the enhanced lines in the chromosphere is shown by the following figures relating to substances which have been most completely studied.

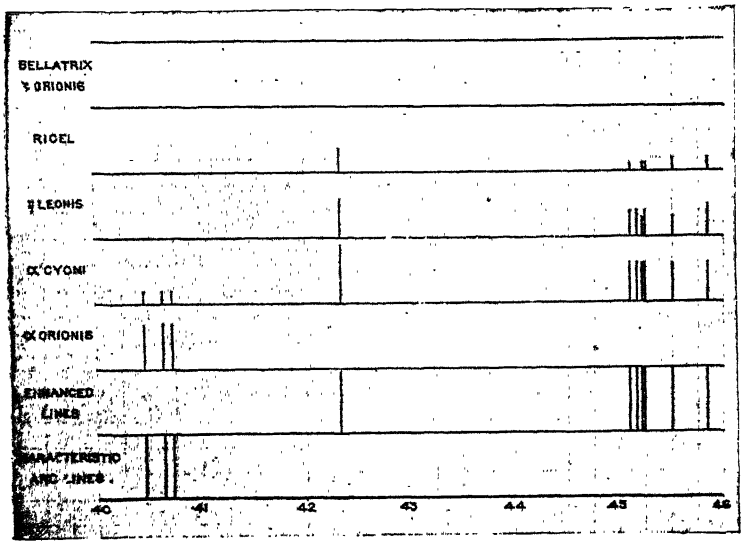

FIG. 16.—The enhanced lines of iron and their appearance in stellar spectra.

No. of enhanced lines of Fe, Mg, Ca, Mn, Ni, Ti, so far tabulated in the region F to K	63
No. of these lines photographed in eclipse of 1893 in the same region	28
Percentage of enhanced lines of Fe, &c., in eclipse of 1893	44
No. of enhanced lines photographed in eclipse of 1896	41
Percentage of enhanced lines of Fe, &c., in eclipse of 1896	65

These numbers show that the chromospheric spectrum is largely composed of enhanced metallic lines in addition to the lines of hydrogen and helium.

In the Fraunhofer spectrum enhanced lines may be regarded as wanting, for in the case of iron and magnesium, at least, they only appear with the feeble intensities which they have in the arc spectrum, while the characteristic arc lines are strong. Here, then, we find the cause of the dissimilarity of the chromospheric and Fraunhofer spectrum, which is indicated by the following figures :—

No. of Fraunhofer lines tabulated by Rowland in the region F to K	5694
No. of lines photographed in the same region, eclipse 1893	164
Percentage of Fraunhofer lines	3
No. of lines photographed in the same region, eclipse 1896	464
Percentage of Fraunhofer lines	8

Clearly, then, the chromosphere as photographed in the eclipses of 1893 and 1896, is a region of high temperature, in which there is a corresponding simplification of spectrum as compared with the cooler region in which the Fraunhofer absorption is produced. The spectrum of the chromosphere is to that of the sun generally as is the spectrum of α Cygni to that of Arcturus. It is obvious that if we can succeed in 1898 to get similar records *with double the dispersion*, an immense stride will have been made, and hence the programme for the coming eclipse to which I have drawn attention.

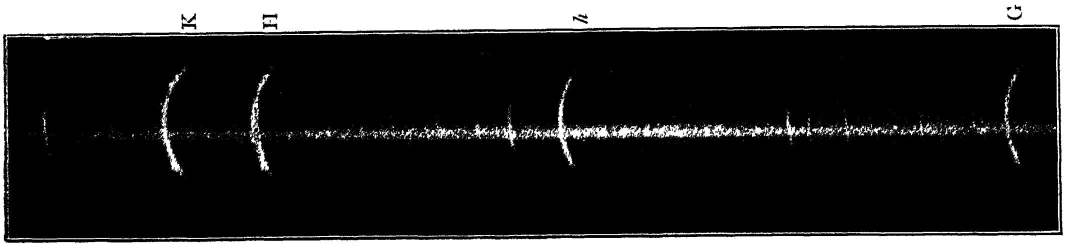

FIG. 17.—Spectrum of chromosphere obtained during the total eclipse of 1896, showing lines photographed between K and G.

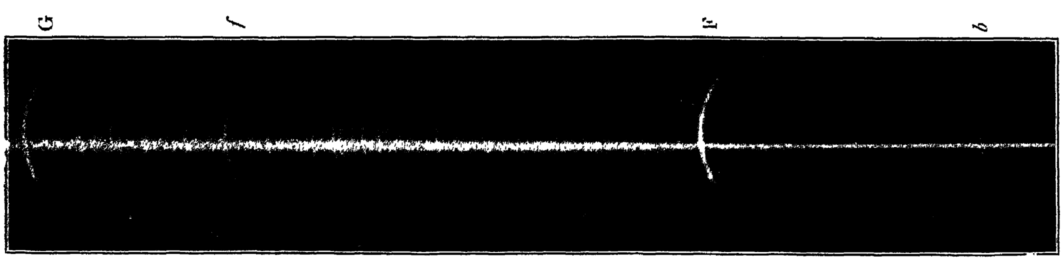

FIG. 18.—Spectrum of chromosphere obtained during the total eclipse of 1896, showing lines photographed between G and *b*.

NORMAN LOCKYER.

(*To be continued.*)

THE BRITISH ASSOCIATION.

Canada is giving a warm reception to the members of the British Association who have gone over to attend the Toronto meeting. A large number of members arrived in Montreal on Monday, and there was a reception at the McGill University, at which about two hundred persons were present. The *Times* reports that the visitors were received by Vice-Principal Johnson, the Governors, and the Fellows, and were conducted in parties over the University, its fine collections, laboratories, &c. Luncheon was served in Molson Hall, and the President of the Governors proposed the toast of the Association. Lord Lister responded, and Sir John Evans proposed the toast of the University. The National Anthem was sung, and afterwards the company drove in carriages to Mount Royal, where a reception was held, which was much appreciated by the Association.

The programme of the meeting at Toronto shows that the time of the members will be fully occupied. The first general meeting took place yesterday as we went to press, and the President's address was delivered in the evening. The Sections meet to-day, and the addresses of the Sectional Presidents were to be delivered this morning. Following our usual custom, we print this week the complete addresses of the President and of the Presidents of Sections A and B. Other sectional addresses will appear in future numbers, and also reports of the work of the Sections.

A large garden party will be given this afternoon at the Royal Canadian Yacht Club, Toronto Island. His Excellency, the Governor-General, and the Countess of Aberdeen will this evening give a reception to the members in the Parliament buildings of the Province of Ontario. To-morrow there will be meetings of the Sections until about three o'clock, when there will be a Convocation of the University of Toronto to confer the honorary degree of Doctor of Laws upon Lord Kelvin, Lord Lister, Sir John Evans and the President of the American Association, Prof. Wolcott Gibbs. After Convocation is over, there will be several garden parties for the members. On Saturday morning the Sections will meet and adjourn early, in order that the members may take the various excursions which have been arranged from Saturday to Monday. On Tuesday next there will be a Convocation of Trinity University to confer the honorary degree of D.C.L. on Lord Lister, Sir John Evans and Prof. Forsyth; this ceremony will be followed by several garden parties. In the evening there will be a conversazione, with music and refreshments, in the main building of the University of Toronto for all the members of the Association. On Wednesday the Sections will meet for their concluding meeting, and in the afternoon the second and last general meeting of the Association will take place.

Inaugural Address by Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., For.Sec.G.S., Correspondant de l'Institut de France, &c., President.

Once more has the Dominion of Canada invited the British Association for the Advancement of Science to hold one of the annual meetings of its members within the Canadian territory; and for a second time has the Association had the honour and pleasure of accepting the proferred hospitality.

In doing so, the Association has felt that if by any possibility the scientific welfare of a locality is promoted by its being the scene of such a meeting, the claims should be fully recognised of those who, though not dwelling in the British Isles, are still inhabitants of that Greater Britain whose prosperity is so intimately connected with the fortunes of the Mother Country.

Here, especially, as loyal subjects of one beloved Sovereign, the sixtieth year of whose beneficent reign has just been celebrated with equal rejoicing in all parts of her Empire; as speaking the same tongue, and as in most instances connected by the ties of one common parentage, we are bound together in all that can promote our common interests.

There is, in all probability, nothing that will tend more to advance those interests than the diffusion of science in all parts of the British Empire, and it is towards this end that the aspirations of the British Association are ever directed, even if in many instances the aim may not be attained.

We are, as already mentioned, indebted to Canada for previous hospitality, but we must also remember that, since the time when we last assembled on this side of the Atlantic, the Dominion has provided the Association with a President, Sir William Dawson, whose name is alike well known in Britain and America, and whose reputation is indeed world-wide. We rejoice that we have still among us the pioneer of American geology, who among other discoveries first made us acquainted with the "Air-breathers of the Coal," the terrestrial or more properly arboreal Saurians of the New Brunswick and Nova Scotia Coal-measures.

On our last visit to Canada, in 1884, our place of assembly was Montreal, a city which is justly proud of her McGill University; to-day we meet within the buildings of another of the Universities of this vast Dominion—and in a city, the absolute fitness of which for such a purpose must have been foreseen by the native Indian tribes when they gave to a small aggregation of huts upon this spot the name of Toronto—"the place of meetings."

Our gathering this year presents a feature of entire novelty and extreme interest, inasmuch as the sister Association of the United States of America—still mourning the loss of her illustrious President, Prof. Cope—and some other learned societies, have made special arrangements to allow of their members coming here to join us. I need hardly say how welcome their presence is, nor how gladly we look forward to their taking part in our discussions, and aiding us by interchange of thought. To such a meeting the term "international" seems almost misapplied. It may rather be described as a family gathering, in which our relatives more or less distant in blood, but still intimately connected with us by language, literature, and habits of thought, have spontaneously arranged to take part.

The domain of science is no doubt one in which the various nations of the civilised world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected? The present year has witnessed an interchange of courtesies which has excited the warmest feelings of approbation on both sides of the Atlantic. I mean the return to its proper custodians of one of the most interesting of the relics of the Pilgrim Fathers, the Log of the *Mayflower*. May this return, trifling in itself, be of happy augury as testifying to the feelings of mutual regard and esteem which animate the hearts both of the donors and of the recipients!

At our meeting in Montreal the President was an investigator who had already attained to a foremost place in the domains of Physics and Mathematics, Lord Rayleigh. In his address he dealt mainly with topics, such as Light, Heat, Sound, and Electricity, on which he is one of our principal authorities. His name and that of his fellow-worker, Prof. Ramsay, are now and will in all future ages be associated with the discovery of the new element, Argon. Of the ingenious methods by which that discovery was made, and the existence of Argon established, this is not the place to speak. One can only hope that the element will not always continue to justify its name by its inertness.

The claims of such a leader in physical science as Lord Rayleigh to occupy the Presidential chair are self-evident, but possibly those of his successor on this side of the Atlantic are not so immediately apparent. I cannot for a moment pretend to place myself on the same purely scientific level as my distinguished friend and for many years colleague, Lord Rayleigh, and my claims, such as they are, seem to me to rest on entirely different grounds.

Whatever little I may have indirectly been able to do in

assisting to promote the advancement of science, my principal efforts have now for many years been directed towards attempting to forge those links in the history of the world, and especially of humanity, that connect the past with the present, and towards tracing that course of evolution which plays as important a part in the physical and moral development of man as it does in that of the animal and vegetable creation.

It appears to me, therefore, that my election to this important post may, in the main, be regarded as a recognition by this Association of the value of Archæology as a science.

Leaving all personal considerations out of question, I gladly hail this recognition, which is, indeed, in full accordance with the attitude already for many years adopted by the Association towards Anthropology, one of the most important branches of true Archæology.

It is no doubt hard to define the exact limits which are to be assigned to Archæology as a science, and Archæology as a branch of History and Belles Lettres. A distinction is frequently drawn between science on the one hand, and knowledge of learning on the other; but translate the terms into Latin, and the distinction at once disappears. In illustration of this I need only cite Bacon's great work on the "Advancement of Learning," which was, with his own aid, translated into Latin under the title, "De Augmentis Scientiarum."

It must, however, be acknowledged that a distinction does exist between Archæology proper, and what, for want of a better word, may be termed Antiquarianism. It may be interesting to know the internal arrangements of a Dominican convent in the middle ages; to distinguish between the different mouldings characteristic of the principal styles of Gothic architecture; to determine whether an English coin bearing the name of Henry was struck under Henry II., Richard, John, or Henry III., or to decide whether some given edifice was erected in Roman, Saxon, or Norman times. But the power to do this, though involving no small degree of detailed knowledge and some acquaintance with scientific methods, can hardly entitle its possessors to be enrolled among the votaries of science.

A familiarity with all the details of Greek and Roman mythology and culture must be regarded as a literary rather than a scientific qualification; and yet when among the records of classical times we come upon traces of manners and customs which have survived for generations, and which seem to throw some rays of light upon the dim past, when history and writing were unknown, we are, I think, approaching the boundaries of scientific Archæology.

Every reader of Virgil knows that the Greeks were not merely orators, but that with a pair of compasses they could describe the movements of the heavens and fix the rising of the stars; but when by modern Astronomy we can determine the heliacal rising of some well-known star, with which the worship in some given ancient temple is known to have been connected, and can fix its position on the horizon at some particular spot, say three thousand years ago, and then find that the axis of the temple is directed exactly towards that spot, we have some trustworthy scientific evidence that the temple in question must have been erected at a date approximately 1100 years B.C. If on or close to the same site we find that more than one temple was erected, each having a different orientation, these variations, following as they may fairly be presumed to do the changing position of the rising of the dominant star, will also afford a guide as to the chronological order of the different foundations. The researches of Mr. Penrose seem to show that in certain Greek temples, of which the date of foundation is known from history, the actual orientation corresponds with that theoretically deduced from astronomical data.

Sir J. Norman Lockyer has shown that what holds good for Greek temples applies to many of far earlier date in Egypt, though up to the present time hardly a sufficient number of accurate observations have been made to justify us in foreseeing all the instructive results that may be expected to arise from Astronomy coming to the aid of Archæology.

The intimate connection of Archæology with other sciences is in no case so evident as with respect to Geology, for when considering subjects such as those I shall presently discuss, it is almost impossible to say where the one science ends and the other begins.

By the application of geological methods many archæological questions relating even to subjects on the borders of the historical period have been satisfactorily solved. A careful examination of the limits of the area over which its smaller coins are found has led to the position of many an ancient Greek city being accurately ascertained; while in England it has only been by treating the coins of the Ancient Britons, belonging to a period before the Roman occupation, as if they were actual fossils, that the territories under the dominion of the various kings and princes who struck them have been approximately determined. In arranging the chronological sequence of these coins, the evolution of their types—a process almost as remarkable, and certainly as well-defined, as any to be found in nature—has served as an efficient guide. I may venture to add that the results obtained from the study of the morphology of this series of coins were published ten years before the appearance of Darwin's great work on the "Origin of Species."

When we come to the consideration of the relics of the Early Iron and Bronze Ages, the aid of Chemistry has of necessity to be invoked. By its means we are able to determine whether the iron of a tool or weapon is of meteoritic or volcanic origin, or has been reduced from iron-ore, in which case considerable knowledge of metallurgy would be involved on the part of those who made it. With bronze antiquities the nature and extent of the alloys combined with the copper may throw light not only on their chronological position, but on the sources whence the copper, tin and other metals of which they consist were originally derived. I am not aware of there being sufficient differences in the analysis of the native copper from different localities in the region in which we are assembled, for Canadian Archæologists to fix the sources from which the metal was obtained which was used in the manufacture of the ancient tools and weapons of copper that are occasionally discovered in this part of the globe.

Like Chemistry, Mineralogy and Petrology may be called to the assistance of Archæology in determining the nature and source of the rocks of which ancient stone implements are made; and, thanks to researches of the followers of those sciences, the old view that all such implements formed of jade and found in Europe must of necessity have been fashioned from material imported from Asia can no longer be maintained. In one respect the Archæologist differs in opinion from the Mineralogist—namely, as to the propriety of chipping off fragments from perfect and highly-finished specimens for the purpose of submitting them to microscopic examination.

I have hitherto been speaking of the aid that other sciences can afford to Archæology when dealing with questions that come almost, if not quite, within the fringe of history, and belong to times when the surface of our earth presented much the same configuration as regards the distribution of land and water, and hill and valley, as it does at present, and when, in all probability, the climate was much the same as it now is. When, however, we come to discuss that remote age in which we find the earliest traces that are at present known of Man's appearance upon earth, the aid of Geology and Palæontology becomes absolutely imperative.

The changes in the surface configuration and in the extent of the land, especially in a country like Britain, as well as the modifications of the fauna and flora since those days, have been such that the Archæologist pure and simple is incompetent to deal with them, and he must either himself undertake the study of these other sciences or call experts in them to his assistance. The evidence that Man had already appeared upon the earth is afforded by stone implements wrought by his hands, and it falls strictly within the province of the Archæologist to judge whether given specimens were so wrought or not; it rests with the Geologist to determine their stratigraphical or chronological position, while the Palæontologist can pronounce upon the age and character of the associated fauna and flora.

If left to himself, the Archæologist seems too prone to build up theories founded upon form alone, irrespective of geological conditions. The Geologist, unaccustomed to archæological details, may readily fail to see the difference between the results of the operations of Nature and those of Art, and may be liable to trace the effects of man's handiwork in the chipping, bruising and wearing which in all ages result from natural forces; but the united labours of the two, checked by those of the Palæontologist, cannot do otherwise than lead towards sound conclusions.

It will, perhaps, be expected of me that I should on the present occasion bring under review the state of our present knowledge with regard to the Antiquity of Man; and probably no fitter place could be found for the discussion of such a topic than the adopted home of my venerated friend, the late Sir Daniel Wilson, who first introduced the word "prehistoric" into the English language.

Some among us may be able to call to mind the excitement, not only among men of science, but among the general public, when, in 1859, the discoveries of M. Boucher de Perthes and Dr. Rigollot in the gravels of the valley of the Somme, at Abbeville and Amiens, were confirmed by the investigations of the late Sir Joseph Prestwich, myself, and others, and the co-existence of Man with the extinct animals of the Quaternary fauna, such as the mammoth and woolly-haired rhinoceros, was first virtually established. It was, at the same time, pointed out that these relics belonged to a far earlier date than the ordinary stone weapons found upon the surface, which usually showed signs of grinding or polishing, and that, in fact, there were two Stone Ages in Britain. To these the terms Neolithic and Palæolithic were subsequently applied by Sir John Lubbock.

The excitement was not less, when, at the meeting of this Association at Aberdeen in the autumn of that year, Sir Charles Lyell, in the presence of the Prince Consort, called attention to the discoveries in the valley of the Somme, the site of which he had himself visited, and to the vast lapse of time indicated by the position of the implements in drift-deposits a hundred feet above the existing river.

The conclusions forced upon those who examined the facts on the spot did not receive immediate acceptance by all who were interested in Geology and Archæology, and fierce were the controversies on the subject that were carried on both in the newspapers and before various learned societies.

It is at the same time instructive and amusing to look back on the discussions of those days. While one class of objectors accounted for the configuration of the flint implements from the gravels by some unknown chemical agency, by the violent and continued gyratory action of water, by fracture resulting from pressure, by rapid cooling when hot or by rapid heating when cold, or even regarded them as aberrant forms of fossil fishes, there were others who, when compelled to acknowledge that the implements were the work of men's hands, attempted to impugn and set aside the evidence as to the circumstances under which they had been discovered. In doing this they adopted the view that the worked flints had either been introduced into the containing beds at a comparatively recent date, or if they actually formed constituent parts of the gravel then that this was a mere modern alluvium resulting from floods at no very remote period.

In the course of a few years the main stream of scientific thought left this controversy behind, though a tendency to cut down the lapse of time necessary for all the changes that have taken place in the configuration of the surface of the earth and in the character of its occupants since the time of the Palæolithic gravels, still survives in the inmost recesses of the hearts of not a few observers.

In his Address to this Association at the Bath meeting of 1864, Sir Charles Lyell struck so true a note that I am tempted to reproduce the paragraph to which I refer :—

"When speculations on the long series of events which occurred in the glacial and post-glacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day that when he was about to contribute somewhat parsimoniously towards a public charity, he was persuaded by a friend to make a more liberal donation. In doing so he apologised for his first apparent want of generosity by saying that his early life had been a constant struggle with scanty means, and that 'they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones.' In like manner we of the living generation, when called upon to make grants of thousands of centuries in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional beliefs, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the Geologist, we feel how hard it is to get the chill of poverty out of our bones."

Many, however, have at the present day got over this feeling, and of late years the general tendency of those engaged upon the question of the antiquity of the human race has been in the direction of seeking for evidence by which the existence of Man upon the earth could be carried back to a date earlier than that of the Quaternary gravels.

There is little doubt that such evidence will eventually be forthcoming, but, judging from all probability, it is not in Northern Europe that the cradle of the human race will eventually be discovered, but in some part of the world more favoured by a tropical climate, where abundant means of subsistence could be procured, and where the necessity for warm clothing did not exist.

Before entering into speculations on this subject, or attempting to lay down the limits within which we may safely accept recent discoveries as firmly established, it will be well to glance at some of the cases in which implements are stated to have been found under circumstances which raise a presumption of the existence of man in pre-Glacial, Pliocene, or even Miocene times.

Flint implements of ordinary Palæolithic type have, for instance, been recorded as found in the Eastern Counties of England, in beds beneath the Chalky Boulder Clay; but on careful examination the geological evidence has not to my mind proved satisfactory, nor has it, I believe, been generally accepted. Moreover, the archæological difficulty that Man, at two such remote epochs as the pre-Glacial and the post-Glacial, even if the term Glacial be limited to the Chalky Boulder Clay, should have manufactured implements so identical in character that they cannot be distinguished apart, seems to have been entirely ignored.

Within the last few months we have had the report of worked flints having been discovered in the late Pliocene Forest Bed of Norfolk, but in that instance the signs of human workmanship upon the flints are by no means apparent to all observers.

But such an antiquity as that of the Forest Bed is as nothing when compared with that which would be implied by the discoveries of the work of men's hands in the Pliocene and Miocene beds of England, France, Italy, and Portugal, which have been accepted by some Geologists. There is one feature in these cases which has hardly received due attention, and that is the isolated character of the reputed discoveries. Had man, for instance, been present in Britain during the Crag Period, it would be strange indeed if the sole traces of his existence that he left were a perforated tooth of a large shark, the sawn rib of a manatee, and a beaming full face, carved on the shell of a pectunculus!

In an address to the Anthropological Section at the Leeds meeting of this Association in 1890 I dealt somewhat fully with these supposed discoveries of the remains of human art in beds of Tertiary date; and I need not here go further into the question. Suffice it to say that I see no reason why the verdict of "not proven" at which I then arrived should be reversed.

In the case of a more recent discovery in Upper Burma in beds at first pronounced to be Upper Miocene, but subsequently "definitely ascertained to be Pliocene," some of the flints are of purely natural and not artificial origin, so that two questions arise: first, Were the fossil remains associated with the worked flints or with those of natural forms? And second, Where they actually found in the bed to which they have been assigned, or did they merely lie together on the surface?

Even the *Pithecanthropus erectus* of Dr. Eugène Dubois from Java meets with some incredulous objectors from both the physiological and the geological sides. From the point of view of the latter the difficulty lies in determining the exact age of what are apparently alluvial beds in the bottom of a river valley.

When we return to Palæolithic man, it is satisfactory to feel that we are treading on comparatively secure ground, and that the discoveries of the last forty years in Britain alone enable us to a great extent to reconstitute his history. We may not know the exact geological period when first he settled in the British area, but we have good evidence that he occupied it at a time when the configuration of the surface was entirely different from what it is at present: when the river valleys had not been cut down to anything like their existing depth, when the fauna of the country was of a totally different character from that of the present day, when the extension of the southern part of the island seaward was in places such that the land was continuous with that of the continent, and when in all probability a far more rainy climate prevailed. We have proofs of the occupation of the country by man during the long lapse of time that was necessary for the excavation of the river valleys. We have

found the old floors on which his habitations were fixed, we have been able to trace him at work on the manufacture of flint instruments, and by building up the one upon the other the flakes struck off by the primæval workman in those remote times we have been able to reconstruct the blocks of flint which served as his material.

That the duration of the Palæolithic Period must have extended over an almost incredible length of time is sufficiently proved by the fact that valleys, some miles in width and of a depth of from 100 to 150 feet, have been eroded since the deposit of the earliest implement-bearing beds. Nor is the apparent duration of this period diminished by the consideration that the floods which hollowed out the valleys were not in all probability of such frequent occurrence as to teach Palæolithic man by experience the danger of settling too near to the streams, for had he kept to the higher slopes of the valley there would have been but little chance of his implements having so constantly formed constituent parts of the gravels deposited by the floods.

The examination of British cave-deposits affords corroborative evidence of this extended duration of the Palæolithic Period. In Kent's Cavern at Torquay, for instance, we find in the lowest deposit, the breccia below the red cave-earth, implements of flint and chert corresponding in all respects with those of the high level and most ancient river gravels. In the cave-earth these are scarcer, though implements occur which also have their analogues in the river deposits; but, what is more remarkable, harpoons of reindeer's horn and needles of bone are present, identical in form and character with those of the caverns of the Reindeer Period in the South of France, and suggestive of some bond of union or identity of descent between the early troglodytes, whose habitations were geographically so widely separated the one from the other.

In a cavern at Creswell Crags, on the confines of Derbyshire and Nottinghamshire, a bone has moreover been found engraved with a representation of parts of a horse in precisely the same style as the engraved bones of the French caves.

It is uncertain whether any of the River-drift specimens belong to so late a date as these artistic cavern-remains; but the greatly superior antiquity of even these to any Neolithic relics is testified by the thick layer of stalagmite, which had been deposited in Kent's Cavern before its occupation by men of the Neolithic and Bronze Periods.

Towards the close of the period covered by the human occupation of the French caves, there seems to have been a dwindling in the number of the larger animals constituting the Quaternary fauna, whereas their remains are present in abundance in the lower and therefore more recent of the valley gravels. This circumstance may afford an argument in favour of regarding the period represented by the later French caves as a continuation of that during which the old river gravels were deposited, and yet the great change in the fauna that has taken place since the latest of the cave-deposits included in the Palæolithic Period is indicative of an immense lapse of time.

How much greater must have been the time required for the more conspicuous change between the old Quaternary fauna of the river gravels and that characteristic of the Neolithic Period!

As has been pointed out by Prof. Boyd Dawkins, only thirty-one out of the forty-eight well-ascertained species living in the post-Glacial or River-drift Period survived into prehistoric or Neolithic times. We have not, indeed, any means at command for estimating the number of centuries which such an important change indicates; but when we remember that the date of the commencement of the Neolithic or Surface Stone Period is still shrouded in the mist of a dim antiquity, and that prior to that commencement the River-drift Period had long come to an end; and when we further take into account the almost inconceivable ages that even under the most favourable conditions the excavation of wide and deep valleys by river action implies, the remoteness of the date at which the Palæolithic Period had its beginning almost transcends our power of imagination.

We find distinct traces of river action from 100 to 200 feet above the level of existing streams and rivers, and sometimes at a great distance from them; we observe old fresh-water deposits on the slopes of valleys several miles in width; we find that long and lofty escarpments of rock have receded unknown distances since their summits were first occupied by Palæolithic man; we see that the whole side of a wide river valley has been carried away by an invasion of the sea, which attacked and removed a barrier of chalk cliffs from 400 to 600 feet in height; we find that what was formerly an inland river has been widened out into an arm of the sea, now the highway of our fleets, and that gravels which were originally deposited in the bed of some ancient river now cap isolated and lofty hills.

And yet, remote as the date of the first known occupation of Britain by man may be, it belongs to what, geologically speaking, must be regarded as a quite recent period, for we are now in a position to fix with some degree of accuracy its place on the geological scale. Thanks to investigations ably carried out at Hoxne in Suffolk, and at Hitchin in Hertfordshire, by Mr. Clement Reid, under the auspices of this Association and of the Royal Society, we know that the implement-bearing beds at those places undoubtedly belong to a time subsequent to the deposit of the Great Chalky Boulder Clay of the Eastern Counties of England. It is, of course, self-evident that this vast deposit, in whatever manner it may have been formed, could not, for centuries after its deposition was complete, have presented a surface inhabitable by man. Moreover, at a distance but little further north, beds exist which also, though at a somewhat later date, were apparently formed under Glacial conditions. At Hoxne the interval between the deposit of the Boulder Clay and of the implement bearing beds is distinctly proved to have witnessed at least two noteworthy changes in climate. The beds immediately reposing on the Clay are characterised by the presence of alder in abundance, of hazel, and yew, as well as by that of numerous flowering plants indicative of a temperate climate very different from that under which the Boulder Clay itself was formed. Above these beds characterised by temperate plants, comes a thick and more recent series of strata, in which leaves of the dwarf Arctic willow and birch abound, and which were in all probability deposited under conditions like those of the cold regions of Siberia and North America.

At a higher level and of more recent date than these—from which they are entirely distinct—are the beds containing Palæolithic implements, formed in all probability under conditions not essentially different from those of the present day. However this may be, we have now conclusive evidence that the Palæolithic implements are, in the Eastern Counties of England, of a date long posterior to that of the Great Chalky Boulder Clay.

It may be said, and said truly, that the implements at Hoxne cannot be shown to belong to the beginning rather than to some later stage of the Palæolithic Period. The changes, however, that have taken place at Hoxne in the surface configuration of the country prove that the beds containing the implements cannot belong to the close of that period.

It must, moreover, be remembered that in what are probably the earliest of the Palæolithic deposits of the Eastern Counties, those at the highest level, near Brandon in Norfolk, where the gravels contain the largest proportion of pebbles derived from Glacial beds, some of the implements themselves have been manufactured from materials not native to the spot but brought from a distance, and derived in all probability either from the Boulder Clay or from some of the beds associated with it.

We must, however, take a wider view of the whole question, for it must not for a moment be supposed that there are the slightest grounds for believing that the civilisation, such as it was, of the Palæolithic Period originated in the British Isles. We find in other countries implements so identical in form and character with British specimens that they might have been manufactured by the same hands. These occur over large areas in France under similar conditions to those that prevail in England. The same forms have been discovered in the ancient river gravels of Italy, Spain, and Portugal. Some few have been recorded from the north of Africa, and analogous types occur in considerable numbers in the south of that continent. On the banks of the Nile, many hundreds of feet above its present level, implements of the European types have been discovered; while in Somaliland, in an ancient river valley at a great elevation above the sea, Mr. Seton-Karr has collected a large number of implements formed of flint and quartzite, which, judging from their form and character, might have been dug out of the drift deposits of the Somme or the Seine, the Thames or the ancient Solent.

In the valley of the Euphrates implements of the same kind have also been found, and again further east in the lateritic deposits of Southern India they have been obtained in considerable numbers. It is not a little remarkable, and is at the same time highly suggestive, that a form of implement almost peculiar to Madras reappears among implements from the very ancient gravels of the Manzanares at Madrid. In the case of the

African discoveries we have as yet no definite Palæontological evidence by which to fix their antiquity, but in the Narbadá Valley of Western India Palæolithic implements of quartzite seem to be associated with a local fauna of Pleistocene age, comprising, like that of Europe, the elephant, hippopotamus, ox, and other mammals of species now extinct. A correlation of the two faunas with a view of ascertaining their chronological relations is beset with many difficulties, but there seems reason for accepting this Indian Pleistocene fauna as in some degree more ancient than the European.

Is this not a case in which the imagination may be fairly invoked in aid of science? May we not from these data attempt in some degree to build up and reconstruct the early history of the human family? There, in Eastern Asia, in a tropical climate, with the means of subsistence readily at hand, may we not picture to ourselves our earliest ancestors, gradually developing from a lowly origin, acquiring a taste for hunting—if not, indeed, being driven to protect themselves from the beasts around them—and evolving the more complicated forms of tools or weapons from the simpler flakes which had previously served them as knives? May we not imagine that, when once the stage of civilisation denoted by these Palæolithic implements had been reached, the game for the hunter became scarcer, and that his life in consequence assumed a more nomad character? Then, and possibly not till then, may a series of migrations to "fresh woods and pastures new" not unnaturally have ensued; and these, following the usual course of "westward towards the setting sun," might eventually lead to a Palæolithic population finding its way to the extreme borders of Western Europe, where we find such numerous traces of its presence.

How long a term of years may be involved in such a migration it is impossible to say, but that such a migration took place the phenomena seem to justify us in believing. It can hardly be supposed that the process that I have shadowed forth was reversed, and that Man, having originated in North-western Europe, in a cold climate where clothing was necessary and food scarce, subsequently migrated eastward to India and southward to the Cape of Good Hope! As yet, our records of discoveries in India and Eastern Asia are but scanty; but it is there that the traces of the cradle of the human race are, in my opinion, to be sought, and possibly future discoveries may place upon a more solid foundation the visionary structure that I have ventured to erect.

It may be thought that my hypothesis does not do justice to what Sir Thomas Browne has so happily termed "that great antiquity, America." I am, however, not here immediately concerned with the important Neolithic remains of all kinds with which this great continent abounds. I am now confining myself to the question of Palæolithic man and his origin, and in considering it I am not unmindful of the Trenton implements, though I must content myself by saying that the "turtle-back" form is essentially different from the majority of those on the wide dissemination of which I have been speculating; and, moreover, as many here present are aware, the circumstances of the finding of these American implements are still under careful discussion.

Leaving them out of the question for the present, it may be thought worth while to carry our speculations rather further, and to consider the relations in time between the Palæolithic and the Neolithic Periods. We have seen that the stage in human civilisation denoted by the use of the ordinary forms of Palæolithic implements must have extended over a vast period of time if we have to allow for the migration of the primeval hunters from their original home, wherever it may have been in Asia or Africa, to the west of Europe, including Britain. We have seen that, during this migration, the forms of the weapons and tools made from silicious stones had become, as it were, stereotyped, and further, that, during the subsequent extended period implied by the erosion of the valleys, the modifications in the form of the implements, and the changes in the fauna associated with the men who used them, were but slight.

At the close of the period during which the valleys were being eroded, comes that represented by the latest occupation of the caves by Palæolithic man, when both in Britain and in the south of France the reindeer was abundant; but among the stone weapons and implements of that long troglodytic phase of man's history, not a single example with the edge sharpened by grinding has as yet been found. All that can safely be said is that the larger implements, as well as the larger mammals, had become scarcer; that greater power in chipping flint had been attained; that the arts of the engraver and the sculptor had considerably developed: and that the use of the bow had probably been discovered.

Directly we encounter the relics of the Neolithic Period, often, in the case of the caves lately mentioned, separated from the earlier remains by a thick layer of underlying stalagmite, we find flint hatchets polished at the edge and on the surface, cutting at the broad (and not at the narrow) end, and other forms of implements associated with a fauna in all essential respects identical with that of the present day.

Were the makers of these polished weapons the direct descendants of Palæolithic ancestors whose occupation of the country was continuous from the days of the old river gravels? or had these long since died out, so that after Western Europe had for ages remained uninhabited, it was re-peopled in Neolithic times by the immigration of some new race of men? Was there, in fact, a "great gulf fixed" between the two occupations? or was there in Europe a gradual transition from the one stage of culture to the other?

It has been said that "what song the Syrens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond all conjecture"; and though the questions now proposed may come under the same category, and must await the discovery of many more essential facts before they receive definite and satisfactory answers, we may, I think, throw some light upon them if we venture to take a few steps upon the seductive, if insecure, paths of conjecture. So far as I know, we have as yet no trustworthy evidence of any transition from the one age to the other, and the gulf between them remains practically unbridged. We can, indeed, hardly name the part of the world in which to seek for the cradle of Neolithic civilisation, though we know that traces of what appear to have been a stone-using people have been discovered in Egypt, and that what must be among the latest of the relics of their industry have been assigned to a date some 3500 to 4000 years before our era. The men of that time had attained to the highest degree of skill in working flint that has ever been reached. Their beautifully-made knives and spear-heads seem indicative of a culminating point reached after long ages of experience; but whence these artists in flint came, or who they were, is at present absolutely unknown, and their handiworks afford no clue to help us in tracing their origin.

Taking a wider survey, we may say that, generally speaking, not only the fauna but the surface configuration of the country were, in Western Europe at all events, much the same at the commencement of the Neolithic Period as they are at the present day. We have, too, no geological indications to aid us in forming any chronological scale.

The occupation of some of the caves in the south of France seems to have been carried on after the erosion of the neighbouring river valleys had ceased, and, so far as our knowledge goes, these caves offer evidence of being the latest in time of those occupied by Man during the Palæolithic Period. It seems barely possible that, though in the north of Europe there are no distinct signs of such late occupation, yet that, in the south, Man may have lived on, though in diminished numbers; and that in some of the caves—such, for instance, as those in the neighbourhood of Mentone—there may be traces of his existence during the transitional period that connects the Palæolithic and Neolithic Ages. If this were really the case, we might expect to find some traces of a dissemination of Neolithic culture from a North Italian centre, but I much doubt whether any such traces actually exist.

If it had been in that part of the world that the transition took place, how are we to account for the abundance of polished stone hatchets found in Central India? Did Neolithic man return eastward by the same route as that by which in remote ages his Palæolithic predecessor had migrated westward? Would it not be in defiance of all probability to answer such a question in the affirmative? We have, it must be confessed, nothing of a substantial character to guide us in these speculations; but, pending the advent of evidence to the contrary, we may, I think, provisionally adopt the view that owing to failure of food, climatal changes, or other causes, the occupation of Western Europe by Palæolithic man absolutely ceased, and that it was not until after an interval of long duration that Europe was re-peopled by a race of men immigrating from some other part of the globe where the human race had survived, and in course of ages had developed a higher stage of culture than that of Palæolithic man.

I have been carried away by the liberty allowed for conjecture into the regions of pure imagination, and must now return to the realms of fact, and one fact on which I desire for a short time to insist is that of the existence at the present day, in close juxtaposition with our own civilisation, of races of men who, at all events but a few generations ago, lived under much the same conditions as did our own Neolithic predecessors in Europe.

The manners and customs of these primitive tribes and peoples are changing day by day, their languages are becoming obsolete, their myths and traditions are dying out, their ancient processes of manufacture are falling into oblivion, and their numbers are rapidly diminishing, so that it seems inevitable that ere long many of these interesting populations will become absolutely extinct. The admirable Bureau of Ethnology instituted by our neighbours in the United States of America has done much towards preserving a knowledge of the various native races in this vast continent; and here in Canada the annual Archæological Reports presented to the Minister of Education are rendering good service in the same cause.

Moreover the Committee of this Association appointed to investigate the physical characters, languages, and industrial and social conditions of the North-western tribes of the Dominion of Canada is about to present its twelfth and final report, which, in conjunction with those already presented, will do much towards preserving a knowledge of the habits and languages of those tribes. It is sad to think that Mr. Horatio Hale, whose comprehensive grasp of the bearings of ethnological questions, and whose unremitting labours have so materially conduced to the success of the Committee, should be no longer among us. Although this report is said to be final, it is to be hoped that the Committee may be able to indicate lines upon which future work in the direction of ethnological and archæological research may be profitably carried on in this part of Her Majesty's dominions.

It is, however, lamentable to notice how little is being, or has been, officially done towards preserving a full record of the habits, beliefs, arts, myths, languages, and physical characteristics of the countless other tribes and nations more or less uncivilised, which are comprised within the limits of the British Empire. At the meeting of this Association held last year at Liverpool, it was resolved by the General Committee "that it is of urgent importance to press upon the Government the necessity of establishing a Bureau of Ethnology for Greater Britian, which by collecting information with regard to the native races within and on the borders of the Empire will prove of immense value to science and to the Government itself." It has been suggested that such a bureau might with the greatest advantage and with the least outlay and permanent expense be connected either with the British Museum or with the Imperial Institute, and the project has already been submitted for the consideration of the Trustees of the former establishment.

The existence of an almost unrivalled ethnological collection in the Museum, and the presence there of officers already well versed in ethnological research, seem to afford an argument in favour of the proposed bureau being connected with it. On the other hand, the Imperial Institute was founded with an especial view to its being a centre around which every interest connected with the dependencies of the Empire might gather for information and support. The establishment within the last twelve months of a Scientific Department within the Institute, with well-appointed laboratories and a highly-trained staff, shows how ready are those concerned in its management to undertake any duties that may conduce to the welfare of the outlying parts of the British Empire; a fact of which I believe that Canada is fully aware. The Institute is therefore likely to develop, so far as its scientific department is concerned, into a bureau of advice in all matters scientific and technical, and certainly a Bureau of Ethnology, such as that suggested, would not be out of place within its walls.

Wherever such an institution is to be established, the question of its existence must of necessity rest with Her Majesty's Government and Treasury, inasmuch as without funds, however moderate, the undertaking cannot be carried on. I trust that in considering the question it will always be borne in mind that in the relations between civilised and uncivilised nations and races it is of the first importance that the prejudices, and especially the religious or semi-religious and caste prejudices, of the latter should be thoroughly well known to the former. If but a single "little war" could be avoided in consequence of the knowledge acquired and stored up by the Bureau of Ethnology preventing such a misunderstanding as might culminate in warfare, the cost of such an institution would quickly be saved.

I fear that it will be thought that I have dwelt too long on primæval man and his modern representatives, and that I should have taken this opportunity to discuss some more general subject, such as the advances made in the various departments of science since last this Association met in Canada. Such a subject would no doubt have afforded an infinity of interesting topics on which to dilate. Spectrum analysis, the origin and nature of celestial bodies, photography, the connection between heat, light, and electricity, the practical applications of the latter, terrestrial magnetism, the liquefaction and solidification of gases, the behaviour of elements and compounds under the influence of extreme cold, the nature and uses of the Röntgen rays, the advances in bacteriology and in prophylactic medicine, might all have been passed under review, and to many of my audience would have seemed to possess greater claims to attention than the subject that I have chosen.

It must, however, be borne in mind that most, if not indeed all, of these topics will be discussed by more competent authorities in the various Sections of the Association by means of the Presidential addresses or otherwise. Nor must it be forgotten that I occupy this position as a representative of Archæology, and am therefore justified in bringing before you a subject in which every member of every race of mankind ought to be interested—the antiquity of the human family and the scenes of its infancy.

Others will direct our thoughts in other directions, but the further we proceed the more clearly shall we realise the connection and inter-dependence of all departments of science. Year after year, as meetings of this Association take place, we may also foresee that "many shall run to and fro and knowledge shall be increased." Year after year advances will be made in science; and in reading that Book of Nature that lies ever open before our eyes, successive stones will be brought for building up that Temple of Knowledge of which our fathers and we have laboured to lay the foundations. May we not well exclaim with old Robert Recorde?—

"Oh woorthy temple of Goddes magnificence: Oh throne of glorye and seate of the lorde: thy substance most pure what tonge can describe? thy signes are so wondrous, surmountinge mannes witte, the effects of thy motions so diuers in kinde: so harde for to searche, and worse for to fynde—Thy woorkes are all wonderous, thy cunning unknowen: yet seedes of all knowledge in that booke are sowen—And yet in that boke who rightly can reade, to all secrete knowledge it will him straighte leade" (Preface to Robert Recorde's "Castle of Knowledge," 1556.)

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. A. R. FORSYTH, M.A., SC.D., F.R.S., PRESIDENT OF THE SECTION.

ONE of the most important events of the past year, connected with the affairs of this Section, has been the reception by the Prime Minister, Lord Salisbury, of a deputation to represent the need for the establishment of a National Physical Laboratory to carry out investigations of certain definite types. Such institutions exist in France and Germany, and have proved of the highest usefulness in a field of work that includes the wide range from pure research to the most direct applications of science to industry. The desire for such an institution in England has long been felt, and as far back as 1891 Prof. Oliver Lodge, when presiding over our Section at the Cardiff meeting, argued in its favour. It has frequently been discussed since that date, particularly in 1895, when Sir Douglas Galton dealt with it so ably in his presidential address at Ipswich, and also in a communication to our Section. The subject was then formally referred to a committee of physicists, who, at last year's meeting in Liverpool, presented a report containing a working scheme for developing the Kew Observatory into an institution of the desired character. The recommendations of the report were approved by a unanimous vote of this Section; and were subsequently adopted by the Association. Thereupon a joint committee, representing the various scientific bodies throughout the United Kingdom interested in the matter, was constituted to

further the plan: in particular, to urge upon the Government the establishment of such a Laboratory, and, if possible, to obtain from them the funds which are a preliminary necessity for that purpose. It was a deputation from this joint committee which, headed by Lord Lister, waited upon the Prime Minister on February 16 last. His reply to the deputation was manifestly sympathetic with the request; there is consequently reasonable ground for supposing that the Government will take the matter into their favourable consideration.

After having said, by way of preface, thus much upon the chief event of the past year arising partly from our direct action, I wish to turn to the main line of my address, and to ask, for a brief time, your attention and your consideration for the subject of pure mathematics. If, remembering the brilliant address made at the Montreal meeting, you regret that Lord Kelvin is not again now occupying this position: or if, remembering the interest aroused by Prof. J. J. Thomson's address last year, you regret that the fascinating tale then opened is not being resumed by some one with imagination enough and knowledge enough to continue it: I can, not unselfishly, share your regret.

It appears, however, from the practice of the Council and the General Committee, to be their policy that mathematicians belonging to the extreme right (if the phrase may be used) shall from time to time be nominated to the presidency of the Section. It is, I think, the case that this Section has always had assigned to it the subjects of Mathematics and Physics. In their development, pure mathematics has continued to be associated with applied mathematics, and applied mathematics with physics. So far as I know, there is no substantial reason why any change should be made, and so far as I have been able to observe, there is a strong consensus of opinion that no change by way of separation need be tried. Wide as is the range of our discussions, distracting as is the occasional variety in the matter of the papers we receive, the complexity of our Section, if in any respect a disadvantage, does not appreciably discount the advantages it otherwise secures. Specialisation in all our subjects has become almost a necessity for progress; but excessive obedience need not be paid to that necessity. On the one hand, there will be danger of imperfect appreciation if a subject is so completely restricted to a few specialists that it is ignored by all but them; and, on the other hand, there will be danger of unsound growth if subject and thinkers alike become isolated, and cease to take an active interest in the methods, the processes, and the results other than those which directly concern them. Accordingly, I think that our group of sciences, which form a continuous range, are better united than divided.

Aristotle declared that it is unbecoming to praise the gods. Observing his canon, I shall say nothing as to the wisdom and the justice of our Executive in sometimes selecting a pure mathematician to preside over this Section. I shall only appeal to your indulgence in accepting the opportunity they have thus given me of speaking more specially about my own subject.

I make this appeal the more earnestly, for two particular reasons. One of these is based upon the conflicting views, popularly held and sometimes summarily expressed, about the subject and those who are addicted to it. It is true that the day has gone by, when it is necessary to give serious consideration to attacks upon mathematical studies, and particularly upon analysis, such as were made by the metaphysician Hamilton: attacks no longer thought worthy of any answer. Feelings of hostility, if ever they were widely held, have given way to other feelings, which in the mildest form suggest toleration and acquiescence, and in the most extreme form suggest solemn respect and distant wonder. By common consent, we are allowed without reproach to pursue our aims; though those aims sometimes attract but little sympathy. It is not so long since, during one of the meetings of the Association, one of the leading English newspapers briefly described a sitting of this Section in the words, "Saturday morning was devoted to pure mathematics, and so there was nothing of any general interest": still, such toleration is better than undisguised and ill-informed hostility. But the attitude of respect, I might almost say of reverence, is even more trying: we mathematicians are supposed to be of a different mould, to live far up the heights above the driving gales of controversy, breathing a rarer intellectual atmosphere, serene in impenetrable calm. It is difficult for us to maintain the gravity of demeanour proper to such superior persons; and perhaps it is best to confess at once that we are of the earth, earthy, that we have our differences of opinion and of judgment, and that we can even commit the Machiavelian crime of making blunders.

The other of my reasons for claiming your indulgence is of a graver character, and consists in the difficulty of framing general explanations about the subject. The fact is that mathematics do not lend themselves readily to general exposition. Clifford, it is true, could lecture and enchant his audience: and yet even his lectures ranged about the threshold of the temple of mathematical knowledge and made no attempt to reveal the shrines in the sanctuary. The explanation of this initial difficulty is, however, at hand. Our vocabulary is highly technical, perhaps as technical as is that of moral philosophers: and yet even the technicality of a vocabulary can be circumvented by prolixity of statement. But the ideas and the subject-matter in any branch of our study, when even only moderately developed, are so abstract as to demand an almost intolerable prolixity of statement if an attempt is made to popularise them. Moreover, of the many results obtained, there are few that appeal to an unprofessional sympathy. Adams could discover a new planet by subjecting observations made of the known planets to the most profound calculations; and the world, not over curious about the process, could appreciate the significant result. But such instances are rare; for the most part, our particular results must remain somewhat intangible, somewhat incomprehensible, to those who dwell resolutely and completely outside the range of mathematical knowledge.

What then am I to do? It would be pleasant to me, though it might not prove satisfying to you, to discourse of the present state of one branch or of several branches of mathematics, and particularly to indicate what seem to be lines of possible and probable growth in the future. Instead of pursuing this course, I shall keep my remarks of a general character as far as possible, and shall attempt, not merely to describe briefly some of the relations of pure mathematics to other branches of science, but also to make a bold claim that the unrestricted cultivation of pure mathematics is desirable in itself and for its own sake. Some—I should like to believe many—who are here will concede this claim to the fullest extent and without reservation; but I doubt whether this is so in general. And yet the claim is one which needs to be made before an English-speaking audience. For it is a curious fact that, although the United Kingdom has possessed some of the very greatest of pure mathematicians in the second half of this century, the subject has there received but a scant share of attention as compared with that which it has found in France, in Germany, in Italy, in Sweden and Norway, or in the United States. I am not oblivious of the magnificent contributions to other parts of our science made alike by British leaders and British followers; their fame is known to the world. But apathy rather than attention has been the characteristic feature of our attitude towards pure mathematics; and it seems to me a misfortune, alike for the intellectual activity of the nation and for the progress of the subject, that English thought has had relatively so small an influence upon its vast modern developments.

Now it is not enough for my purpose to be told that the British Association includes all science in its scope, and consequently includes pure mathematics. A statement thus made might be framed in a spirit of mere sufferance; what I wish to secure is a recognition of the subject as one which, being full of life and overflowing with a power of growth, is worthy of the most absorbing devotion. The most cursory examination of the opinions of scientific men leads at once to the conclusion, that there are two views of the subject, both accurate so far as they go, both inadequate whether alone or combined, which to some extent explain if they do not justify what may be called the English attitude in the past. Let me deal with these in succession.

One of these estimates has been framed by what is called the practical man; he regards the subject as a machine which is to provide him with tables, as far as tables can be calculated; and with the simplest formulæ and the most direct rules, whenever tables cannot be calculated. Results, not methods, are his want; it is sufficient for him that an authoritative statement as to a result shall be made; all else is ignored. And for what is beyond, in the shape of work that does nothing to meet his special wants, or of the processes that have led to the results he uses, he cares little or nothing. In fact, he would regard mathematics as a collection of formulæ and an aggregate of processes to grind out numerical results; whatever else there is in it, may be vain and is useless. In his view, it is to be the drudge of the practical sciences.

Now it is undoubtedly an advantage in any case that labour should be saved and time economised; and where this can be done, either by means of calculations made once for all or by processes that lead to results admitting simple formulation, any mathematician will be glad, particularly if his own work should lead to some such issue. But he should not be expected to consider that his science has thus fulfilled its highest purpose; and perhaps he is not unreasonable if, when he says that such results are but a very small part, and not the most interesting part, of his science, he should claim a higher regard for the whole of it. Indeed, I rather suspect that some change is coming; the practical man himself is changing. The developments in the training for a profession, for example, that of an engineer, and the demands that arise in the practice of the profession, are such as to force gradually a complete change of view. When I look into the text-books that he uses, it seems to me a necessity that an engineer should now possess a mathematical skill and knowledge in some directions which, not so very long since, could not freely be found among the professional mathematicians themselves. And as this change is gradually effected, perhaps the practical man will gradually change his estimate of the scope of mathematical science.

I pass from the practical man to some of the natural philosophers. Many of them, though certainly far from all of them, expound what they consider proper and economical limits to the development of pure mathematics. Their wisdom gives varied reasons; it speaks in tones of varied appreciation; but there can be no doubt as to its significance and its meaning. Their aim is to make pure mathematics, not indeed the drudge, but the handmaid of the sciences. The demand requires examination, and deserves respectful consideration. There is no question of giving or withholding help in furthering, in every possible fashion and with every possible facility, the progress of natural philosophy; there is no room for difference upon that matter. The difference arises when the opinion is expressed or the advice is tendered that the activity of mathematicians and all their investigations should be consciously limited, and directed solely and supremely, to the assistance and the furtherance of natural philosophy.

One group of physicists, adopting a distinctly aggressive attitude in imposing limits so as to secure prudence in the pursuit of pure mathematics, regard the subject as useful solely for arriving at results connected with one or other of the branches of natural philosophy; they entertain an honest dislike, not merely to investigations that do not lead to such results, but to the desirability of carrying out such investigations; and some of them have used highly flavoured rhetoric in expressing their dislike. It would be easy—but unconvincing—to suggest that, with due modifications in statement, they might find themselves faced with the necessity of defending some of their own researches against attacks as honestly delivered by men absorbed in purely practical work. But such a suggestion is no reply, for it does not in the least touch the question at issue; and I prefer to meet their contention with a direct negative.

By way of illustration let me take a special instance: it is not selected as being easier to confute than any other, but because it was put in the forefront by one of the vigorous advocates of the contention under discussion—a man of the highest scientific distinction in his day. He wrote: "Measured [by the utility of the power they give] partial differential equations are very useful, and therefore stand very high [in the range of pure mathematics] as far as the second order. They apply to that point in the most important way to the great problems of nature, and are worthy of the most careful study. Beyond that order they apply to nothing." This last statement, it may be remarked, is inaccurate; for partial differential equations, of an order higher than the second, occur—to give merely a few examples—in investigations as to the action of magnetism on polarised light, in researches on the vibrations of thick plates or of curved bars, in the discussion of such hydrodynamical questions as the motion of a cylinder in fluid or the damping of air-waves owing to viscosity.

Putting this aside, what is more important is the consideration of the partial differential equations of the second order that are found actually to occur in the investigations. Each case as it arises is discussed solely in connection with its particular problem; one or two methods are given, more or less in the form of rules; if these methods fail, the attempt at solution subsides. The result is a collection of isolated processes, about as unsatisfactory a collection as is the chapter labelled Theory of Numbers in many text-books on algebra, when it is supposed to represent that great branch of knowledge. Moreover, this method suffers from the additional disadvantage of suggesting little or no information about equations of higher orders.

But when the equations are considered, not each by itself but as ranged under a whole system, then the investigation of the full theory places these processes in their proper position, gives them a meaning which superficially they do not exhibit, and indicates the way in which each solution satisfies the general conditions of existence of a solution. For the full theory of partial differential equations of the second order in, say, two independent variables establishes the conditions of existence of a solution, the limitations upon the conditions which make that solution unique, the range of variation within which that solution exists, the modes of obtaining expressions for it when it can be expressed in a finite form, and an expression for the solution when it cannot be expressed in a finite form. Of course, the actual derivation of the solution of particular equations is dependent upon analytical skill, as is always the case in any piece of calculating work; but the general theory indicates the possibilities and the limitations which determine the kind of solution to be expected. But not only does the general theory effect much by way of coordinating isolated processes—and, in doing so, lead to new results—but it gives important indications for dealing with equations of higher orders, and it establishes certain theorems about them merely by simple generalisations.

In fact, the special case quoted is one more instance, added to the many instances that have occurred in the past, in which the utilitarian bias in the progress of knowledge is neither the best stimulus nor in the long run the most effective guide towards securing results. It may be—it frequently is—at first the only guide possible, and for a time it continues the best guide, but it does not remain so for ever. It would be superfluous, after Cayley's address in 1883, to show how branches of mathematical physics, thus begun and developed, have added to knowledge in their own direction; they have suggested, they have even created, most fascinating branches of pure mathematics, which, when developed, have sometimes proved of reciprocal advantage to the source from which they sprang. But for proper and useful development they must be free from the restrictions which the sterner group of natural philosophers would lay upon them.

Now I come to another group of natural philosophers who will unreservedly grant my contention thus far; who will yield a ready interest to our aims and our ideas, but who consider that the possibility of applying our results in the domain of physical science should regulate, or at least guide, advance in our work. Some of these entertain this view because they think that possibility of early application is, in the last resource, the real test of useful development; some, because they fear that the profusion of papers annually published and the bewildering specialisation in each branch, are without purpose, and may ultimately lead to isolation or separation of whole sections of mathematics from the general progress of science.

The danger arising from excess of activity seems to me unreal; at any rate there are not signs of it at home at the present day, and I would gladly see more workers at pure mathematics, though not of course at the expense of attention paid to any other branch. But for results that are trivial, for investigations that have no place in organic growth and development, or in illustration and elucidation, surely the natural end is that they soon subside into mere tricks of "curious pleasure or ingenious pain." However numerous they may be, they do not possess intrinsic influence sufficient to cause evil consequences, and any attempt at repression will, if successful, inevitably and unwisely repress much more.

More attention must be paid to the suggestion that mathematicians should be guided in their investigations by the possibility of practical issues. That they are so guided to a great extent is manifest from many of the papers written in that spirit; that they cannot accept practical issues as the sole guide would seem sufficiently justified by the consideration that practical issues widen from year to year and cannot be foreseen in the absence of a divining spirit. Moreover, if such a principle were adopted, many an investigation undertaken at the time for its intrinsic interest would be cast on one side unconsidered, because it does not satisfy an external test that really has nothing to do with the case, and may change its form of application from time to time.

To emphasise this opinion that mathematicians would be unwise to accept practical issues as the sole guide or the chief guide in the current of their investigations, it may be sufficient to recall a few instances from history in which the purely mathematical discovery preceded the practical application and was not an elucidation or an explanation of observed phenomena. The fundamental properties of conic sections were known to the Greeks in the fourth and the third centuries before the Christian era; but they remained unused for a couple of thousand years until Kepler and Newton found in them the solution of the universe. Need I do more than mention the discovery of the planet Neptune by Adams and Leverrier, in which the intricate analysis used had not been elaborated for such particular applications? Again, it was by the use of refined analytical and geometrical reasoning upon the properties of the wave-surface that Sir W. R. Hamilton inferred the existence of conical refraction which, down to the time when he made his inference, had been "unsupported by any facts observed, and was even opposed to all the analogies derived from experience."

It may be said that these are time-honoured illustrations, and that objections are not entertained as regards the past, but fears are entertained as regards the present and future. Very well; let me take one more instance, by choosing a subject in which the purely mathematical interest is deemed supreme, the theory of functions of a complex variable. That at least is a theory in pure mathematics, initiated in that region and developed in that region; it is built up in scores of papers, and its plan certainly has not been, and is not now, dominated or guided by considerations of applicability to natural phenomena. Yet what has turned out to be its relation to practical issues? The investigations of Lagrange and others upon the construction of maps appear as a portion of the general property of conformal representation; which is merely the general geometrical method of regarding functional relations in that theory. Again, the interesting and important investigations upon discontinuous two-dimensional fluid motion in hydrodynamics, made in the last twenty years, can all be, and now are all, I believe, deduced from similar considerations by interpreting functional relations between complex variables. In the dynamics of a rotating heavy body, the only substantial extension of our knowledge made since the time of Lagrange has accrued from associating the general properties of functions with the discussion of the equations of motion. Further, under the title of conjugate functions, the theory has been applied to various questions in electrostatics, particularly in connection with condensers and electrometers. And, lastly, in the domain of physical astronomy, some of the most conspicuous advances made in the last few years have been achieved by introducing into the discussion the ideas, the principles, the methods, and the results of the theory of functions. It is unnecessary to speak in detail of this last matter, for I can refer you to Dr. G. W. Hill's interesting "Presidential Address to the American Mathematical Society" in 1895; but without doubt the refined and extremely difficult work of Poincaré and others in physical astronomy has been possible only by the use of the most elaborate developments of some pure mathematical subjects, developments which were made without a thought of such applications.

Now it is true that much of the theory of functions is as yet devoid of explicit application to definite physical subjects; it may be that these latest applications exhaust the possibilities in that direction for any immediate future; and it is also true that whole regions of other theories remain similarly unapplied. Opinion and divination as to the future would be as vain as they are unnecessary; but my contention does not need to be supported by speculative hopes or uninformed prophecy.

If in the range of human endeavour after sound knowledge there is one subject that needs to be practical, it surely is Medicine. Yet in the field of Medicine it has been found that branches such as biology and pathology must be studied for themselves and be developed by themselves with the single aim of increasing knowledge; and it is then that they can be best applied to the conduct of living processes. So also in the pursuit of mathematics, the path of practical utility is too narrow and irregular, not always leading far. The witness of history shows that, in the field of natural philosophy, mathematics will furnish more effective assistance if, in its systematic development, its course can freely pass beyond the ever-shifting domain of use and application.

What I have said thus far has dealt with considerations arising from the outside. I have tried to show that, in order to secure the greatest benefit for those practical or pure sciences which use mathematical results or methods, a deeper source of possible advantage can be obtained by developing the subject independently than by keeping the attention fixed chiefly upon the applications that may be made. Even if no more were said, it might be conceded that the unrestricted study of mathematics would thereby be justified. But there is another side to this discussion, and it is my wish now to speak very briefly from the point of view of the subject itself, regarded as a branch of knowledge worthy of attention in and for itself, steadily growing and full of increasing vitality. Unless some account be taken of this position, an adequate estimate of the subject cannot be framed; in fact, nearly the greater part of it will thus be omitted from consideration. For it is not too much to say that, while many of the most important developments have not been brought into practical application, yet they are as truly real contributions to human knowledge as are the disinterested developments of any other of the branches included in the scope of pure science.

It will readily be conceded for the present purpose that knowledge is good in and by itself, and that the pursuit of pure knowledge is an occupation worthy of the greatest efforts which the human intellect can make. A refusal to concede so much would, in effect, be a condemnation of one of the cherished ideals of our race. But the mere pursuit or the mere assiduous accumulation of knowledge is not the chief object; the chief object is to possess it sifted and rationalised: in fact, organised into truth. To achieve this end, instruments are requisite that may deal with the respective well-defined groups of knowledge, and for one particular group, we use the various sciences. There is no doubt that, in this sense, mathematics is a great instrument; there remains for consideration the decision as to its range and function—are they such as to constitute it an independent science, or do they assign it a position in some other science?

I do not know of any canonical aggregate of tests which a subject should satisfy before it is entitled to a separate establishment; but, in the absence of a recognised aggregate, some important tests can be assigned which are necessary, and may, perhaps, be sufficient. A subject must be concerned with a range of ideas forming a class distinct from all other classes; it must deal with them in such a way that new ideas of the same kind can be associated and assimilated; and it should derive a growing vigour from a growing increase of its range. For its progress, it must possess methods as varied as its range, acquiring and constructing new processes in its growth; and new methods on any grand scale should supersede the older ones, so that increase of ideas and introduction of new principles should lead both to simplification and to increase of working power within the subject. As a sign of its vitality, it must ever be adding to knowledge and producing new results, even though within its own range it propound some questions that have no answer and other questions that for a time defy solution; and results already achieved should be an intrinsic stimulus to further development in the extension of knowledge. Lastly, at least among this list, let me quote Sylvester's words: "It must unceasingly call forth the faculties of observation and comparison; one of its principal methods must be induction; it must have frequent recourse to experimental trial and verification, and it must afford a boundless scope for the highest efforts of imagination and invention." I do not add as a test that it must immediately be capable of practical application to something outside its own range, though of course its processes may be also transferable to other subjects, or, in part, derivable from them.

All these tests are satisfied by pure mathematics: it can be claimed without hesitation or exaggeration that they are satisfied with ample generosity. A complete proof of this declaration would force me to trespass long upon your time, and so I propose to illustrate it by references to only two or three branches.

First, I would refer to the general theory of invariants and covariants. The fundamental object of that theory is the investigation and the classification of all dependent functions which conserve their form unaltered in spite of certain general transformations effected in the functions upon which they depend. Originally it began as the observation of a mere analytical property of a particular expression, interesting enough in itself, but absolutely isolated. This then suggested the inverse question: What is the general law of existence of

such functions if they exist as more than mere casual and isolated occurrences? and how can they all be determined? The answer to these questions led to the construction of the algebraical theory of invariants for linear transformations, and subsequently to the establishment of covariantive forms in all their classes. Next came the question of determining what is practically the range of their existence: that is, is there a complete finite system of such functions in each particular case? and if there is, how is it composed, when in a form that ought to admit of no further reduction? These questions, indeed, are not yet fully answered.

While all this development of the theory of invariants was made upon these lines, without thought of application to other subjects, it was soon clear that it would modify them greatly. It has invaded the domain of geometry, and has almost re-created the analytical theory; but it has done more than this, for the investigations of Cayley have required a full reconsideration of the very foundations of geometry. It has exercised a profound influence upon the theory of algebraical equations; it has made its way into the theory of differential equations; and the generalisation of its ideas is opening out new regions of the most advanced and profound functional analysis. And so far from its course being completed, its questions fully answered, or its interest extinct, there is no reason to suppose that a term can be assigned to its growth and its influence.

As one reference has already been made to the theory of functions of a complex variable, in regard to some of the ways in which it is providing new methods in applied mathematics, I shall deal with it quite briefly now. The theory was, in effect, founded by Cauchy; but, outside his own investigations, it at first made slow and hestitating progress. At the present day, its fundamental ideas may be said almost to govern most departments of the analysis of continuous quantity. On many of them, it has shed a completely new light; it has educed relations between them before unknown. It may be doubted whether any subject is at the present day so richly endowed with variety of method and fertility of resource; its activity is prodigious, and no less remarkable than its activity is its freshness. All this development and increase of knowledge are due to the fact that we face at once the difficulty which even the schoolboy meets in dealing with quadratic equations, when he obtains "impossible" roots; instead of taking the wily x as our subject of operation, we take the still wilier $x + y\sqrt{-1}$ for that purpose, and the result is a transfiguration of analysis.

In passing, let me mention one other contribution which this theory has made to knowledge lying somewhat outside our track. During the rigorous revision to which the foundations of the theory have been subjected in its re-establishment by Weierstrass, new ideas as regards number and continuity have been introduced. With him and with others influenced by him, there has thence sprung a new theory of higher arithmetic; and with its growth, much has concurrently been effected in the elucidation of the general notions of number and quantity. I have already pointed out that the foundations of geometry have had to be re-considered on account of results finding their origin in the theory of invariants and covariants. It thus appears to be the fact that, as with Plato, or Descartes, or Leibnitz, or Kant, the activity of pure mathematics is again lending some assistance to the better comprehension of those notions of time, space, number, quantity, which underlie a philosophical conception of the universe.

The theory of groups furnishes another illustration in the same direction. It was begun as a theory to develop the general laws that govern operations of substitution and transformation of elements in expressions that involve a number of quantities: it soon revolutionised the theory of equations. Wider ideas successively introduced have led to successive extensions of the original foundation, and now it deals with groups of operations of all kinds, finite and infinite, discrete and continuous, with far-reaching and fruitful applications over practically the whole of our domain.

So one subject after another might be considered, all leading to the same conclusion. I might cite the theory of numbers, which has attracted so many of the keenest intellects among men, and has grown to be one of the most beautiful and wonderful theories among the many in the wide range of pure mathematics; or without entering upon the question whether geometry is a pure or an applied science, I might review its growth alike in its projective, its descriptive, its analytical, and its numerative divisions; or I might trace the influence of the idea of continuity in binding together subjects so diverse as arithmetic, geometry, and functionality. What has been said already may, however, suffice to give some slight indication of the vast and ever-widening extent of pure mathematics. No less than in any other science knowledge gathers force as it grows, and each new step once attained becomes the starting-point for steady advance in further exploration. Mathematics is one of the oldest of the sciences; it is also one of the most active, for its strength is the vigour of perpetual youth.

In conclusion, a few words are due to the personal losses caused since our last meeting. It is but little more than two years since Cayley passed away; his life had been full of work, unhasting and unresting in the almost placid course of his great mental strength. While Cayley was yet alive, one name used to be coupled with his when reference was made to English pure mathematics; the two great men were regarded as England's not unworthy contribution to the exploration of the most abstract of the sciences. These fellow-workers, diverse in temperament, in genius, in method, were bound by a friendship that was ended only by death. And now Sylvester too has gone; full of years and honours; though he lived long, he lived young, and he was happily active until practically the very end. Overflowing with an exuberant vitality alike in thought and work, he preserved through life the somewhat rare faculty of instilling his enthusiasm into others. Among his many great qualities, not the least forcible were his vivid imagination, his eager spirit, and his abundant eloquence. When he spoke and wrote of his investigations, or of the subject to which the greater part of his thinking life had been devoted, he did it with the fascination of conviction; and at times—for instance, in his presidential address to this Section at Exeter in 1869—he became so possessed with his sense of the high mission of mathematics, that his utterances had the lofty note of the prophet and the seer.

One other name must be singled out as claiming the passing tribute of our homage; for, in February last, the illustrious and venerable Weierstrass died. He was unconnected with our Association; but science is wider than our body, and we can recognise and salute a master of marvellous influence and unchallenged eminence.

Thus, even to mention no others, pure mathematics has in a brief period lost three of the very greatest of its pioneers and constructors who have ever lived. We know their genius; and the world of thought, though poorer by their loss, is richer by their work.

> Tho' much is taken, much abides, and tho'
> We are not now that strength which in old days
> Moved earth and heaven; that which we are, we are:
> One equal temper of heroic hearts,
> Made weak by time and fate, but strong in will
> To strive, to seek, to find, and not to yield.

Knowledge cannot halt though her heroes fall: the example of their life-long devotion to her progress, and the memory of their achievements, can inspire us and, if need be, can stimulate us in realising the purpose for which we are banded together as an Association—the advancement of science.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. WILLIAM RAMSAY, PH.D., LL.D., SC.D., F.R.S., PRESIDENT OF THE SECTION.

An Undiscovered Gas.

A SECTIONAL address to members of the British Association falls under one of three heads. It may be historical, or actual, or prophetic; it may refer to the past, the present, or the future. In many cases, indeed in all, this classification overlaps. Your former Presidents have given sometimes a historical introduction, followed by an account of the actual state of some branch of our science, and, though rarely, concluding with prophetic remarks. To those who have an affection for the past, the historical side appeals forcibly; to the practical man, and to the investigator engaged in research, the actual, perhaps, presents more charm; while to the general public, to whom novelty is often more of an attraction than truth, the prophetic aspect excites most interest. In this address I must endeavour to tickle all palates; and perhaps I may be excused if I take this opportunity of indulging in the dangerous luxury of prophecy, a luxury which the managers of scientific journals do not often permit their readers to taste.

The subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property—it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only twenty-six letters in our alphabet, and there are already over seventy elements. To select a name expressible by a symbol which has not already been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element.

It is now my task to bring before you the evidence for the existence of this undiscovered element.

It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium, and barium formed such a group; their oxides, lime, strontia, and baryta are all easily slaked, combining with water to form soluble lime-water, strontia-water, and baryta-water. Their sulphates are all sparingly soluble, and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42·5, and 65; and the atomic weight of strontium, 42·5, is the arithmetical mean of those of the other two elements, for $(65+20)/2=42·5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as "Döbereiner's triads."

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterwards elaborated by Kremers, Gladstone, and Cooke. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus, the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous; Dumas, in 1857, contrived a somewhat complicated expression which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine, and iodine; and also of nitrogen, phosphorus, arsenic, antimony and bismuth.

The upshot of these efforts to discover regularity was that, in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an octave in music." To this regularity he gave the name "The Law of Octaves."

The development of this idea, as all chemists know, was due to the late Prof. Lothar Meyer, of Tübingen, and to Prof. Mendeléeff, of St. Petersburg. It is generally known as the "Periodic Law." One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeléeff, that the elements grouped down each of the vertical lines form a natural class; they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting-points, and many of their other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approximately equal atomic weights. The elements in question are iron, cobalt, and nickel; palladium, rhodium, and ruthenium; and platinum, iridium, and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth. And the discovery of such a group is not unlikely, for when this table was first drawn up Prof. Mendeléeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium, and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly 20, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt, and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium, and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, and not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not 20, and that it followed chlorine in the atomic table, and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35·5, and that of potassium, the next element in order in the table, is 39·1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favour of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but, unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and, indeed, have practically demonstrated that argon is a simple substance, and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are clèveite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, &c. The spectrum of helium is characterised by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Profs. Frankland and Lockyer in the spectrum of the sun's chromosphere, and named "helium" at that early date.

The density of helium proved to be very close to 2·0, and, like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight therefore is identical with its molecular weight, viz. 4·0, and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7·0.

The difference between the atomic weights of helium and argon is thus 36, or 40 − 4. Now there are several cases of such a difference. For instance, in the group the first member of which is fluorine we have—

Fluorine...	19	
		16·5
Chlorine..	35·5	
		19·5
Manganese	55	

In the oxygen group—

Oxygen	16	
		16
Sulphur	32	
		20·3
Chromium	52·3	

In the nitrogen group—

Nitrogen	14	
		17
Phosphorus	31	
		20·4
Vanadium	51·4	

And in the carbon group—

Carbon	12	
		16·3
Silicon	28·3	
		19·8
Titanium	48·1	

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are—

Manganese − Fluorine	36
Chromium − Oxygen...	36·3
Vanadium − Nitrogen	37·4
Titanium − Carbon	36·1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than than of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still further, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements.

My assistant, Mr. Morris Travers, has indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed no doubt with negative properties, and the whole world to find it in. Still, the attempt had to be made.

We first directed our attention to the sources of helium—minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral—malacone—gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium), and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm.

Among the minerals examined was one to which our attention had been directed by Prof. Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium.

During a trip to Iceland in 1895, I collected some gas from the boiling springs there; it consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water. In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject. Shortly after the discovery of helium, its spectrum was very carefully examined by Profs. Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the "ultra-violet" and "infra-red." The lines thus registered were found to have a harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Profs. Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was, in reality, a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Prof. Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube; and shortly after Prof. Runge acknowledged his mistake.

These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896 by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2·0; and on the other, a sample of density 2·4 or thereabouts. The difficulty was increased by the curious behaviour, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1·874; but this corresponds to a real density of about 2·0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now Lord Rayleigh found that helium offers less opposition to the passage of light than any other substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion. And the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular; therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schützenberger (whose recent death all chemists have to deplore), and later, by Mr. Crookes, that what we term the atomic weight of an element is a mean; that when we say the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

We therefore thought it necessary to test this question by direct experiment with some known gas; and we chose nitrogen, as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After thirty rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portion which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion—*i.e.* with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful; but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical unity into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two litres. It was filled with helium, and the operation of diffusion was carried through thirty times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot, the lighter portion of the next was added, and in this manner all six reservoirs were successfully passed through the diffusion apparatus. This process was carried out thirty times, each of the six reservoirs having had its gas diffused each time, thus involving 180 diffusions. After this process, the density of the more quickly diffusing gas was reduced to 2·02, while that of the less quickly diffusing had increased to 2·27. The light portion on re-diffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and the last third. A similar set of operations was carried out with a fresh quantity of helium, in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and re-diffused. The density of the lightest portion of these gases was 1·98; and after other 15 diffusions, the density of the lightest portion had not decreased. The end had been reached; it was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1·98; and its refractivity, air being taken as unity, is 0·1245. The spectrum

of this portion does not differ in any respect from the usual spectrum of helium.

As re-diffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated; or that if there are more elements than one present, they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt, and nickel; but there is no proof that this idea is correct, and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole amount of the gas, must, in the present state of our knowledge, be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by re-diffusion, and this would imply that it consists of a small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated re-diffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2·275, and its refractive index was found to be 0·1333. On re-diffusing this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well-known blue lines of argon became visible; and even without the jar the red lines of argon, and the two green groups were distinctly visible. The amount of argon present, calculated from the density, was 1·64 per cent., and from the refractivity 1·14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but, so far as can be made out, merely a small amount of argon.

If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method, other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled on the material which contains it. In fact, the haystack is too large and the needle too inconspicuous. Reference to the periodic table will show that between the elements aluminium and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognised only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight in 100,000 of the mineral; and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it, the analogy with other elements is all that we have to guide us.

We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon, viz. 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less, the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow liker each other, the lower the atomic weights. Now, helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is a somewhat greater difference between lithium and potassium. And it is in accordance with this fragment of regularity that helium and argon show a greater difference. Then again, sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium; and we might, therefore, expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this: The atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements, we have:

$$\mathrm{Li}=7,\ \mathrm{Be}=9\cdot8,\ \mathrm{B}=11,\ \mathrm{C}=12,\ \mathrm{N}=14,\ \mathrm{O}=16,\ \mathrm{F}=19,\ ?=20.$$

The differences are:

$$2\cdot8,\ 1\cdot2,\ 1\cdot0,\ 2\cdot0,\ 2\cdot0,\ 3\cdot0,\ 1\cdot0.$$

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

$$(?=20),\ \mathrm{Na}=23,\ \mathrm{Mg}=24\cdot3,\ \mathrm{Al}=27,\ \mathrm{Si}=28,\ \mathrm{P}=31,\ \mathrm{S}=32,\ \mathrm{Cl}=35\cdot5,\ \mathrm{A}=40.$$

And the differences:

$$3\cdot0,\ 1\cdot3,\ 2\cdot7,\ 1\cdot0,\ 3\cdot0,\ 1\cdot0,\ 3\cdot5,\ 4\cdot5.$$

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of $-0\cdot9$; that is to say, argon has a higher atomic weight than potassium by 0·9 unit; whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Further on in the table there is a similar discrepancy. The row is as follows:

$$\mathrm{Ag}=108,\ \mathrm{Cd}=112,\ \mathrm{In}=114,\ \mathrm{Sn}=119,\ \mathrm{Sb}=120\cdot5,\ \mathrm{Te}=127\cdot7,\ \mathrm{I}=127.$$

The differences are:

$$4\cdot0,\ 2\cdot0,\ 5\cdot0,\ 1\cdot5,\ 7\cdot2,\ -0\cdot7.$$

Here, again, there is a negative difference between tellurium and iodine. And this apparent discrepancy has led to many and careful redeterminations of the atomic weight of tellurium. Prof. Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determinations of its atomic weight give practically the same number, 127·7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these "combining proportions" which we term "atomic weights"? And is there any reason to suppose that we can modify them at our will? Are they true "constants of nature," unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged?

In order to understand the real scope of such questions, it is necessary to consider the relation of the "atomic weights" to other magnitudes, and especially to the important quantity termed "energy."

It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classifies some of these forms of energy as follows:

Kinetic energy	is the product of	Mass into the square of velocity.	
Linear	,,	,,	Length into force.
Surface	,,	,,	Surface into surface tension.
Volume	,,	,,	Volume into pressure.
Heat	,,	,,	Heat capacity (entropy) into temperature.
Electrical	,,	,,	Electrical capacity into potential.
Chemical	,,	,,	"Atomic weight" into affinity.

In each statement of factors, the "capacity factor" is placed first, and the "intensity factor" second.

In considering the "capacity factors," it is noticeable that they may be divided into two classes. The two first kinds of energy, kinetic and linear, are *independent of the nature of the material* which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of two grammes of hydrogen, contained in a vessel of one litre capacity, is equal to that of thirty-two grammes of oxygen at the same temperature, and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead; that is, equal atomic masses have the same heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent; that is, to some simple fraction of its atomic weight. And the capacity factor of chemical energy is the atomic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies, all other kinds of energy are connected with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term "matter") need not necessarily be measured by its inertia, or by gravitational attraction. In fact the word "mass" has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word "mass" has come to denote "quantity of matter." But it is open to any one to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal; or that "equal numbers of atoms" represent equal quantities of matter. Indeed, we regard the value of material as due rather to what it can do, than to its mass; and we buy food, in the main, on an atomic, or perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer.

The various forms of energy may therefore be classified as those which can be referred to an "atomic" factor, and those which possess a "mass" factor. The former are in the majority. And the periodic law is the bridge between them; and yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain "constants of nature"; or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavoured to fulfil my promise to combine a little history, a little actuality, and a little prophecy. The history belongs to the Old World; I have endeavoured to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the ocean.

NOTES.

WE are glad to learn that Lord Armstrong, who has for the past few days been suffering from a slight sunstroke, is now much better. Dr. Gibb, of Newcastle, who was hastily summoned to Bamburgh Castle on Sunday, anticipates that if the progress is maintained his lordship will be quite well again by the end of the week.

LIEUT. DE GERLACHE'S expedition to the Antarctic regions left Antwerp on Monday on board the steamer *Belgica*.

PROF. CORFIELD has been elected an honorary member of the Royal Society of Public Health of Belgium, of which he has been a corresponding member for some years.

A SPECIAL number of the *Rendiconti della R. Accademia dei Lincei* announces the award of the following prizes, besides others for essays of a literary character:—The Royal Prize for physics to Prof. Adolfo Bartoli, of Padua, for his two monographs on the specific heat of water between the temperatures of 0° and 35°, and on the heat of the sun, and for other investigations. For the Ministerial Prize for physical and chemical science eight competitors entered, and the judges have awarded a prize of 1000 lire to Prof. Carlo Bonacini, of Modena, for his essays on orthochromatic and colour photography, and on the reflection and other properties of Röntgen rays; also awards of 250 lire each to Prof. Carlo Cattaneo, of Turin, for his notes on the conductivity of electrolytes and on the velocity of ions, and to Prof. Pietro Bartolotti for chemical investigations relating to the compound Rottlerine and other derivatives.

Science of August 6 prints a long article, by Mr. Cyrus Adler, on the movement towards an international catalogue of scientific works, and reprints the official reports of the proceedings of the conference held at the Royal Society a year ago. The report which the American delegates, Prof. Simon Newcomb and Dr. John S. Billings, presented to the Secretary of State, was, in accordance with their suggestion, referred to the Secretary of the Smithsonian Institution for his views as to the propriety and feasibility of the work proposed being undertaken by that Institution, and as to the probable cost. After considering the matter, Mr. S. P. Langley replied that if the work should be assigned to the Institution, a grant of not less than ten thousand dollars per annum would be required to carry it out. This reply and the documents to which it refers were transmitted to the U.S. Senate and House of Representatives towards the close of last year; and though no result has yet been reached, it is hoped that Congress will give support to the proposal, so that when the time comes the funds needed for cataloguing the scientific publications of the United States will be granted.

THE meeting of the French Association for the Advancement of Science, which opened at St. Étienne on August 5, was concluded on Saturday last. At the opening of the meeting, the President, M. Marey, gave an address on "La méthode graphique et les sciences experimentales." The address is printed in the *Revue Scientifique* for August 7. Next year's meeting will be at Nantes, while in 1899 the congress will be held at Boulogne, in order that visits may be exchanged with members of the British Association at Dover.

THE St. Petersburg correspondent of the *Times* reports that at Peterhof on Tuesday morning thirty-six members of the twelfth International Medical Congress, which is to be opened to-day at Moscow, were presented to the Tsar. Each country sending delegates was represented by a small deputation of its more eminent men now present in St. Petersburg, chosen from about 6000 altogether who are expected to attend the congress. The British representatives who had the honour of a presentation

were Sir William MacCormac, Sir William Stokes, from Ireland, Prof. Stevenson, from Scotland, and Prof. Stevenson, of Netley, on behalf of the medical department of the British Army. On arriving at Peterhof by boat the party were met by Dr. Hirsch, the Tsar's medical attendant, and conducted in Court carriages to the Palace, where luncheon was served to them in the Hall of Mirrors. Each group was subsequently introduced to the presence of the Emperor, who gave them a cordial welcome. The Tsaritsa was also present.

WE regret to record the death of Mr. S. E. Peal, of Assam, a frequent correspondent to these columns, and the author of a number of papers on astronomical subjects. We also notice the announcement of the death of Mr. Samuel Laing, author of "Modern Science and Modern Thought," and many other popular works of a similar character; Hofrath Dr. Alfred Ritter von Arneth, president of the Vienna Academy of Sciences; Prof. de Volson Wood, professor of mechanical engineering in the Stevens Institute of Technology, Hoboken, and formerly professor of mathematics and mechanics in the same institute; and Dr. Tholozan, Correspondant in the Section of Medicine and Surgery of the Paris Academy of Sciences.

THE death is announced of Mr. Albert Marth, for many years a Fellow of the Royal Astronomical Society, to the publications of which he contributed a large number of valuable papers, particularly ephemerides for the satellites of the planets, and for physical observations of Mars and Jupiter. Mr. Marth (says the *Athenæum*) was born at Colberg, in Pomerania, on May 5, 1828, but came to England after he had completed his studies at Berlin and Königsberg, and was connected with the observatories at Regent's Park and Durham, afterwards assisting Lassell with his nebular and other observations at Malta. He discovered the small planet Amphitrite, No. 29, at Mr. Bishop's observatory in 1854. During the last nine years of his life he had been in charge of Colonel Cooper's observatory at Markree Castle, Co. Sligo; but his health had been failing, and he died somewhat suddenly whilst on a visit to his native country.

A LARGE party of Prof. W. K. Brooks' biological students from the Johns Hopkins University, under the charge of Prof. J. E. Humphrey, are at present at Jamaica studying the tropical fauna and flora, and carrying on research work at the north-east side of the island.

WE learn from *Science* that the following grants have been made to the United States Geological Survey for the present fiscal year: The topographical surveys, 175,000 dols.; for geological surveys and researches, 100,000 dols.; for investigation of coal and gold in Alaska, 5000 dols.; palæontology, 10,000 dols.; chemistry, 7000 dols.; gauging streams and water-supply, 50,000 dols.; mineral resources, 20,000 dols. There are also allowances for illustrations, printing, &c.

THE September issue of the *American Naturalist* will appear under entirely new management. The magazine has been purchased from the estate of the late Prof. Edward D. Cope by a number of gentlemen who are interested in the advancement of the natural sciences, and Dr. Robert P. Bigelow, of the Massachusetts Institute of Technology, Boston, has accepted the post of editor-in-chief. He will be assisted by an editorial committee and by a board of associate editors.

AT the beginning of next year, the Boyden Premium of the Franklin Institute, Philadelphia, will be awarded. The premium is the sum of one thousand dollars, and it will be to "any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity." The memoirs describing in detail the apparatus employed in investigating this question, the mode of experimenting, and the results obtained, must be sent in before January 1, 1898.

WE learn from the *Times* that it has been decided to appoint, in place of Mr. Rigby, late Superintendent of the Government Factory at Enfield, who has retired on a pension, a new officer with the title of Deputy-Director-General of the Ordnance Factories. He will receive a salary of 1500*l*. a year, with a suitable residence and with title to a pension. He will have primary charge of the Enfield Factory, but he will also assist the Director-General, Sir William Anderson, F.R.S., in his duties at Woolwich.

THE ninth International Congress of Hygiene and Demography will be held in Madrid from April 10 to 17, 1898.

WE have received from the Hon. Stephen Coleridge, Hon. Secretary of the Anti-vivisection Society, a copy of some correspondence which recently took place in the *St. James's Gazette* with reference to the use of curare in the practice of vivisection. Under the influence of curare it is believed that animals are still conscious of pain, and allegations have been made against some physiologists that they had used curare as an anæsthetic. We do not, as a rule, devote any attention to the reckless assertions so often made by anti-vivisectionists, our reason being that they are usually the result of ignorance which moves us more to pity than to anger. But as the correspondence referred to has apparently been sent to us for comment, we do not hesitate to say that we are astounded at the audacious impudence of persons who venture to criticise matters about which they know nothing. Not content with the Home Secretary's reply to Mr. Weir, in the House of Commons, that the charges made as to the mis-use of curare morphia were "absolutely baseless," Mr. Coleridge extracts from certain papers by Messrs. Bayliss, Hill, and Gulland the words: "Throughout the experiments morphia was the anæsthetic used," and triumphantly points to the "atrocious suffering" involved in experiments so performed. In the course of a reply to this attack, Mr. Leonard Hill said: "It is my invariable rule to perform all cutting operations on animals under complete chloroform anæsthesia. . . . It would be idle to repeat the full details of anæsthesia in every paper published in a journal of pure science—details which are, as a matter of course, recognised by all scientific readers. From such papers the officials of the Anti-vivisection Society piece together defamatory statements. The experiments decried by Edward Berdoe and Mr. Coleridge were carried out without the infliction of pain, and at the end of these experiments the animals were killed. It is my habit to inject from half to one grain of acetate of morphia into small dogs—a dose so large that it cannot be given with safety to an adult man. Such doses produce absolute coma in the animals. The use of morphia to prolong anæsthesia after the initial use of chloroform is a practice common among surgeons." We accept entirely Mr. Hill's explanation, and are amazed at the perverse interpretations which Mr. Coleridge and his fellow-agitators are good enough to put upon the writings of physiologists. The chief source of regret to us is that organisations like the Anti-vivisection Society, existing as they do upon the gullibility of an ill-informed public, should be permitted to publish their irresponsible accusations without fear of punishment. It would be better for humanity as well as science if such societies were not allowed to exist.

A MOTOR-CAR race from Paris to Trouville, which excited as much interest as that from Paris to Dieppe, took place on Sunday last. A correspondent of the *Times* reports that twenty-two motor cars, of various designs, and twenty-six motor cycles started from St. Germain between 10 and 10.30 in the

morning. The distance to Trouville is about 108 miles, and the motor cycle and car first in the Dieppe race also arrived first on Sunday. M. Jannin on his cycle rode the distance under four hours, while M. Gille's Hourgières-Bollée carriage covered the 108 miles in four hours and twenty minutes. Twelve of the motor cycles arrived in less than six hours, and seven of the cars in the same time.

THE first annual report on the work of the Geological Survey of Cape Colony has just been published. Prof. G. S. Corstorphine, the geologist to the Colony, throws cold water upon the belief that payable coal-seams exist beneath the Karoo. He points out that, though it is just possible a coal-seam may be found among the shales of the Karoo, the hope of such a lucky find becomes almost daily less, and the probability of an extensive coal deposit underlying the Karoo is very slight. Deep boring has been again and again advocated as a sure means of discovering coal, but Dr. Corstorphine says that so far there is no evidence geologically to warrant the renewal of such an expensive procedure as deep boring with such a purpose; and this conclusion is not only based upon the work carried out under his direction last year, but also on the results of previous investigations. The question of a probably water-supply from deep boring having been brought before the Commission, Dr. Corstorphine and Mr. A. W. Rogers (assistant geologist) made a preliminary survey of the Oudtshoorn and Prince Albert districts with a view to the selection of a site for a deep bore-hole. But so little is known about the structure of the country and the rocks composing it, that the people who are crying out for deep boring for artesian water will have to exercise a little patience, unless they are willing to provide a large sum of money to be spent upon a series of purely experimental bores. A large amount of information has yet to be obtained before a geologist would give an opinion as to the existence of considerable quantities of water at great depths in the Colony. The Commission, therefore, concludes (and rightly so) that an expenditure upon a deep bore-hole with the idea of finding water would be premature in the present state of knowledge.

AT the International Meteorological Conference held at Paris in September last, Mr. C. L. Wragge, Government Meteorologist for Queensland, drew attention to the importance of establishing an observatory on the top of Mount Kosciusko, in the south-eastern extremity of Australia, at a height of about 8000 feet. The conference expressed the opinion that such a station would possess really scientific importance, and that it would be useful to publish hourly observations made there. We are glad to learn from the *Brisbane Courier* that the Hon. R. Barr-Smith, of Torrens Park, South Australia, has offered to subscribe the whole amount necessary for the establishment of a tentative station at the summit of the above-mentioned mountain. Mr. Wragge hopes that the comparison of the results with those obtained from low-level stations will ensure a permanent observatory being established in the interest of Australasia.

DURING the last thirteen years the Indian Department of Revenue and Agriculture has published memoranda on the snowfall in the mountain districts, with forecasts of the probable character of the south-west monsoons. These statements and forecasts are drawn up by the Government Meteorological Reporter, and have been found of considerable use in predicting the probability of abnormal rainfall during the monsoon period of June to September, heavy and prolonged snowfall in the Western Himalayan area either preventing or delaying the extension of the monsoon current during the rainy season. The investigation seems to show that the general conditions are not unfavourable to the establishment of at least normal monsoon currents, although in parts there has been more snow than usual. It also shows that there has been a cyclical variation in the rainfall during the past five years; 1892–94 were characterised by excessive rain, and in the next two years the rainfall was deficient. The conclusion drawn from this is that there is considerable probability that the present year will be one of deficient rainfall and be the last year of the cycle, but that it will be much less unfavourable than last year. The variations in the rainfall are supposed to be due to some general, but as yet unknown, causes affecting a much larger area than India.

THERE are so many unsettled points with reference to the mode of formation of hailstones that careful observations of the internal structure of hailstones are always of interest, inasmuch as they may prove of assistance in working out the development-history of these meteoric objects. For this reason we are glad to note the following details which Dr. Alex. Hodgkinson observed in hailstones that fell in Wilmslow, Cheshire, during a storm of great severity on August 5. The hail varied in size from seven-eighths of an inch downwards, and the general shape was more or less conical with convex bases. As to the internal structure, Dr. Hodgkinson writes as follows:—"A nucleus of variable size existed in each hailstone, and this was surrounded by an outer layer of clear ice. In some of the larger specimens an intermediate zone of slightly opaque ice was seen, but more transparent than the nucleus. Under the microscope, with a power of about twenty diameters, the structure of the nucleus was seen to be coarsely crystalline, and profusely interspersed with minute air-bubbles, reminding one forcibly of the vacuoles which so frequently occur in specimens of quartz, and give rise to its opalescent appearance. The intermediate zone, when present, was constituted by the existence of similar vacuoles, but far smaller, and no crystalline structure was here perceptible. The outermost layer consisted of clear ice, apparently structureless under the microscope; but with the naked eye, and by variations in the incident light, this might be seen to possess a coarsely radiating structure, as if composed of large radiating crystals. On embedding a hailstone in a piece of perforated card, and examining with polarised light, there was no indication of tangential and radial strain in the body as a whole. The outer and intermediate layers were isotropic, but the individual crystals of the nucleus were distinctly double-refractive."

A DETAILED description of the large seismometrograph recently placed in the observatory of Catania is contributed by Prof. A. Riccò to vol. x. series 4ª of the *Dagli Atti dell' Accademia Gioenia di Scienze Naturali in Catania*. Prof. Riccò was led to erect this instrument because those of a similar character at Rome and Rocca di Papa gave such excellent results. The description is accompanied by an excellent photograph taken by means of the flash light.

FROM Profs. Elster and Geitel we have received a reprint of their last paper, published in *Wiedemann's Annalen*, dealing with the relation between the photo-voltaic current and the kathodic absorption of light when the angle of incidence and direction of polarisation of the incident light are varied. The experiments, which were conducted with the assistance of the Elizabeth Thompson Science Fund, of Boston, show that the current, so far as it depends on these factors, is determined by the amount of light absorbed at the kathode, and the agreement between the curves representing the current and the absorption affords a striking confirmation of the theory of metallic reflection.

ABOUT a quarter of a century has elapsed since Father Bertelli made his first observations on the microseismic movements of the ground. The accuracy of his results was soon disputed, because his pendulums were suspended from a bracket attached to the wall of his observatory, and a long and indecisive

controversy ensued, which has at last been concluded by an interesting paper by M. S. Arcidiacono in the *Bollettino* of the Italian Seismological Society. The observations described in this memoir were made for more than three years with two normal tromometers at the observatory of Catania, one suspended from a thick wall, the other from an isolated column built on an old lava-stream. It was found that the mean displacement of the former instrument almost invariably exceeded that of the latter, though not differing greatly from it. Both tromometers show a prevalence of north-and-south displacements, due probably to the existence of Etna on the north; but the planes of oscillation coincided on only 381 days, while they differed on 667 days. One important conclusion is that, so far as regards magnitude of displacement, a normal tromometer suspended from the wall of a building may give useful results.

Aus dem Archiv der Deutschen Seewarte (nineteenth year, 1896), published under the direction of the Seewarte, contains four contributions of interest. The first of these is by Herrn. E. Knipping, who points out the importance of examining minutely the log-books of vessels with regard to the meteorological records, and the publication of the chief and most important results gained thereform. He gives also samples of how the observations may be most simply printed and used as references. The appendix contains an application of the method advocated, the log-books employed being those that were contained in home-coming ships during the month of January in 1894. The second article is an addition to a previous one, which dealt with experiments relating to the "stopping down," or reduction in size, of the side-lights carried by ships. "Tafeln für die Vorausberechnung der Sternbedeckungen" is the title of the third part, and is contributed by Dr. Carl Stechert. This contains a description of the formulæ and tables for the prediction of occultations of stars, and a clear explanation as to how they should be used, both as regards approximate and very accurate results. The fourth and last part is perhaps the most important, and is by Herrn. E. Engelenburg, formerly Director of the Königl. Niederl. Meteorolog. Observatoriums in Utrecht. The subject dealt with is the aerodynamic theory of storms, and is preceded by a capital historical summary of the various theories propounded down to the present day. The article is too long and important to be discussed here, so we must simply refer our readers directly to the original. We may mention that a very useful "Litteratur-Nachweis" is attached.

AN interesting memoir, by C. T. Mörner, has recently appeared in the *Zeitschrift für physiologische Chemie*, dealing with a method of preserving fish, much employed in many parts of the northern districts of Sweden. The freshly-caught fish are cleaned, washed, and placed in wooden casks, and are then covered with brine. The casks are then closed and made air-tight, and placed in the open air in a sunny place, and allowed to remain there for from five to six weeks. The process of fermentation, which soon ensues, is controlled by means of a small vent-hole, which is opened from time to time. If the fermentation becomes too active the casks are placed in the shade, or some cooler place is chosen for them. As soon as the requisite stage in the process has been reached, the casks are opened, and the now-finished article is packed in smaller vessels for storage and distribution. This article of diet, known in Swedish as "surfisk," is eaten either raw or toasted. Mörner has endeavoured to ascertain what is the nature of the chemical products elaborated during the process of fermentation to which the fish are submitted. As accounting for the disagreeable odour which characterises this preparation, Mörner found amongst the gases emitted during fermentation the offensive-smelling methylmercaptan. Amongst the organic acids discovered in the "surfisk," whilst absent in the fresh fish, succinic acid, butyric acid, formic, acetic, and valeric acids were detected, whilst large quantities of ammonia and some ptomaïnes were also found, amongst the latter being choline and leucine. Curiously indol, skatol, phenol, putrescine and cadaverine, so characteristic of putrefactive processes in general, were absent in this preparation.

THE increasing interest taken in British bird-life has encouraged the editors of *Knowledge* to permanently devote a considerable space in each number to notes on the habits, distribution, migration, and so on, of British birds. A number of well-known ornithologists, including, amongst others, Messrs. W. Eagle Clarke, J. Cordeaux, H. E. Dresser, W. Warde Fowler, J. A. Harvie-Brown, and Thomas Southwell, have promised contributions. The department will be conducted by Mr. Harry F. Witherby.

THE discovery of human and other remains in the Halberstadt Cave, Jamaica, and of rock-carvings at St. John's, aroused considerable interest in the subject of aboriginal remains in the island. An exhibition of such remains, illustrating the life and customs of the aboriginal inhabitants, was held in the museum of the Institute of Jamaica at the end of 1895, and it not only brought to notice a number of relics not previously known, but led to various discoveries and investigations of importance to the anthropology of Jamaica and of the West Indies generally. Mr. J. E. Duerden, the curator of the museum, has prepared an interesting illustrated report upon these "Aboriginal Indian Remains in Jamaica," and has included in it a note, by Prof. A. C. Haddon, upon the craniology of the aborigines.

THE following are among the papers and other publications which have come under our notice within the past few days: *Indian Museum Notes* (vol. iv. No. 2), issued by the Trustees of the Indian Museum, Calcutta. Among the contents are short papers on a new species of Buprestid beetle (*Julodis atkinsoni*); two new species of gall-aphid; the well-known "Pipsa" fly (*Simulium indicum*); and many useful notes on insect pests and remedies.—The fifth part of Mr. Oswin A. J. Lee's fine work, entitled "Among British Birds in their Nesting Haunts, illustrated by the Camera" (Edinburgh: David Douglas), has been published. Previous issues of this work have already been noticed; the present part contains the plates illustrating the nests of the Corn Crake, Chaffinch, Capercaillie, Snipe, Mute Swan, Golden-crested Wren, and Sandpiper. Brief descriptions of the habits and haunts of these birds accompany the plates.—A critical review of the methods of determining minerals is contributed to the *Journal of the Franklin Institute* (August), by Dr. Joseph W. Richards.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. Walter Chamberlain; four Common Hedgehogs (*Erinaceus europæus*), British, presented by Mr. Evelyn Pelly; a Slender-billed Cockatoo (*Licmetis nasica*) from South Australia, presented by Mrs. M. D. Vibart; a Matamata Terrapin (*Chelys fimbriata*) from North Brazil, presented by Mr. W. J. Crummach; two Ribbon Snakes (*Tropidonotus saurita*), seven Striped Snakes (*Tropidonotus ordinatus sirtalis*), four Dekay's Snakes (*Ischnognathus dekayi*), two American Milk Snakes (*Coronella triangulum*), two Grass Snakes (*Contia vernalis*) from North America, presented by Mr. J. H. Fleming; a Grey Lemur (*Hapalemur griseus*) from Madagascar, three Altai Deer (*Cervus* sp. inc., ♂ ♀ ♀) from the Altai Mountains, a Circasian Wild Goat (*Capra caucasica*, ♂) from Caucasus, deposited; one Greater Vasa Parrot (*Coracopsis vasa*) from Madagascar, purchased; two Viscachas (*Lagostomus trichodactylus*), three Barbary Wild Sheep (*Ovis tragelaphus*), a Spotted Tinamou (*Nothura maculosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

CONDITIONS FOR BEST TELESCOPIC DEFINITION.—Dr. T. J. J. See brings together a few facts and remarks regarding the conditions essential to good seeing with large telescopes and high magnifying powers (*Astr. Nachr.*, No. 3438). These are based not only on his own experience under very favourable circumstances during the past year, but many of the suggestions developed are, as he says, the outcome of Mr. Douglass' work on atmospheric currents and their relation to astronomical seeing. At the Harvard station in Peru the seeing at three o'clock in the morning was nearly always bad, caused, as was discovered, by a current of cold air from the valley draining the great mountains above and rushing down the adjacent gorge flowing over the observatory, and completely ruining the seeing almost instantaneously. Such currents as these must always be avoided when fixing upon a position for an observatory, and this is one of many causes which produce bad definition. The country in which good conditions might be depended on should be free from mountains and cyclonic causes which disturb the equilibrium of the atmosphere. A high and dry table-land, distant from oceanic influence, like the northern part of Arizona, presents conditions which are almost ideal when snow is not present. Mountain sites are always less satisfactory than broad table-lands, because currents forced up from below are cooled by expansion due to diminished pressure, and rapid changes are likely to take place when the wind is strong. When covered with snow and overflown by currents of a different temperature, mountain sites are wholly incapable of giving good definition.

ASTRONOMICAL PHOTOGRAPHY FOR SMALL AND LARGE APERTURES.—In this column (April 8, vol. lv. p. 544) we have previously referred to the remarks which Dr. Isaac Roberts published in *Knowledge* (vol. xx. p. 100) regarding the probable limit in the length of the time of exposure for astronomical photography. In these he showed that his experience led him to conclude that in consequence of prolonged exposure to the latent sky luminosity the film of the negative darkened on development to a degree that would obscure faint nebulosity and faint stars, and that longer exposures of the plates would not reveal additional details of nebulosity, nor more faint star images.

Prof. F. L. O. Wadsworth is not, however, inclined to agree with Dr. Roberts' statement in every particular, and contributes to the *Astronomischen Nachrichten* (No. 3439) an article of great interest, dealing with the question under discussion, in which he states his reasons. This should be read by all who employ the camera for astronomical photography, whether the apertures they use be half an inch or twelve inches. We give here the conclusions.

The absolute intensity of the image of a celestial object, and therefore the absolute photographic light action (product of intensity by time), for a given time of exposure will vary (1) for extended sources as the square of the angular aperture only; (2) for point sources as the product of the square of the angular aperture times the square of the linear aperture.

The contrast between the image of any celestial object (not very near the horizon) and the general field depends upon (1) the brightness of the sky at the time; (2) the efficiency of the image-forming lens as regards perfection of figure and curvature of surfaces, &c.; and (3) upon the square of the linear aperture. If the objectives are good, the sky effect (1) and (3) is the most important.

For faint extended objects, such as nebulæ, irresolvable star clouds, &c., in which we have to deal with the delineation of a surface rather than with individual points, this contrast can only be increased by decreasing the focal length. When the sky effect (1) and (3) is predominant, it will vary inversely as the square of the latter quantity.

For point sources the contrast can only be increased by increasing the angular aperture. Under the same conditions as just mentioned in the last paragraph, it will vary directly as the square of this quantity.

It is the degree of contrast and not size of objective (except in so far as this latter influences the contrast) that determines the limiting magnitude of the faintest object that can be photographed. This limiting magnitude for stars depends, therefore, only on the angular aperture, for nebulæ on the focal length.

The time of exposure also depends very largely on the contrast between image and field, and not on the absolute intensity of the former.

As regards the influence of the character of the objective upon the illumination of the field, the refractor seems to have a decided advantage. The angular aperture of the latter should not, however, be greater than 1 to 5.

To photograph the very faintest stars (beyond 17th mag.) a reflector of the largest possible angular aperture, *i.e.* 1 to 3 or 1 to 2, if possible, is the only instrument that can be used.

NEW VARIABLE STARS.—Mr. Thomas D. Anderson communicates to the *Astronomischen Nachrichten* (No. 3440) the discovery of a new variable star in the constellation of Hercules; its position for 1855·0 being R.A. 16h. 55·0m., Declination +31° 26′. Mr. Anderson noted this star some time ago as being a very faint star of the 9th magnitude, and of about the same brightness as B.D. +31°·2949. Several times in the autumn of last year he was unable to see it with his 2·25 inch-refractor, although he could always see a 9·6 mag. star which is not given in the B.D., but whose coordinates for 1855 are approximately 16h. 55·2m. and +31° 34′. This year, on the 22nd and 26th of last month, he has found the missing object, and it was then brighter than the neighbouring star just mentioned. Its brightness was then estimated as being the same as B.D. +31°·2949 with a magnitude of 9·2. As a guide to those who wish to observe this variable, Mr. Anderson says that it lies further from +31°·2951 than from 2949, and also that +31°·2945, 2946, 2949, the variable, and the 9·6 mag. comparison star are nearly in a straight line.

In the same number of the *Astronomischen Nachrichten*, Mr. Stanley Williams gives a list of seven probably new variable stars which he observed on his way to Australia and back. These variables are, however, all of considerable southern declination, but we may mention three of which the variability "appears to be almost beyond doubt."

Star.	1875. R.A. h. m.	Decl. ° ′
L 1713 Cœli ...	5 0·0 ...	−35 53
δ Antliæ ...	10 23·8 ...	−29 58
L 4959 Crucis ...	11 51·9 ...	−55 37

PLANETARY NOTES.—At the oppositions of Jupiter in 1895–96 and 1897, M. Quénisset made some interesting observations of this planet, using a refractor of 16 centimetres aperture, which will be found recorded in the *Bulletin de la Société Astronomique de France* for the present month. Accompanying these are some excellent drawings made by him during those periods of observation. We notice that he has adopted the nomenclature of Lord Ross, Knobel, and Campani for the different zones of the planet by which the positions of special surface markings can be easily located. Why should not all observers of Jupiter adopt the same method, for would not comparisons of different observations be thus rendered more simple? Dr. Fontséré's observations of Venus, which appear in the same number of the *Bulletin*, were made in the first months of this year at the Barcelona Observatory. The surface markings seem to have been clearly seen and recorded, while projections on the terminator and limb were very commonly visible. This observer deduces a long period of rotation for this planet. The observations made by Dr. Peyra during the 1896–97 opposition of Mars appear in the *Memorie della Société degli Spettroscopisti Italiani* (vol. xxvi. 4ª). These were made with a 24-centimetre Merz refractor, and are well worth comparing with those of other observers made about the same time. The drawings accompanying the observations are on rather a small scale, and show only the more prominent markings and canals.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. RODET, the well-known bacteriologist of Lyons, has been appointed Professor of Bacteriology in the University of Lyons.

MR. STANLEY DUNKERLEY, of the Department of Applied Mechanics, Cambridge, has been appointed Professor of Applied Mechanics at the Royal Naval College, Greenwich, in succession to Prof. J. H. Cotterill, F.R.S., who is about to retire after over twenty-four years' service.

THE candidates successful in this year's competition for the Whitworth scholarships and exhibitions are as follows:—(1) Scholarships of 150*l.* (tenable for three years): George M.

Russell, George M. Brown, William Du B. Duddell, George Wilson. (2) Exhibitions of 50*l*. (tenable for one year): George Service, Edgar J. Kipps, Frank Piercy, Arthur Morley, A. Marshall Downie, John R. Powell, Alfred D. Owen, Charles C. Allen, William J. Rouse, Arthur E. Holmes, Alfred T. J. Kersey, Edward C. Horsley, John Berry, James Turnbull, Thomas Taylor, Robert L. Wills, James Paton, Henry T. Sisson, Leonard Ward, Arthur W. Loveridge, Timothy A. Thomas, William Bell, John R. Billington, George Powell, Edgar W. Riley, John S. Marshall, John S. Hague, Frederick Walford, James Davidson, Robert Nelson.

THIS year's successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science), awarded by the Department of Science and Art are as follows:—Royal Exhibitions: Robert L. Sherlock, Gilbert E. James, Howard M. Rootham, Andrew W. Lehmann, William Griffiths, Frank H. Phillips, Alfred L. Oke. National Scholarships for Mechanics (Group A): Arthur W. Ashton, Paul S. Couldrey, Frank Mould, Arthur Morley, Albert Hall, Charles H. Stewart, William W. Firth, George Wall, Alfred T. J. Kersey, John S. Hague. Free Studentships for Mechanics: Arthur W. Loveridge, Percy M. Bennett, Hubert W. Bywaters. National Scholarships for Chemistry and Physics: George H. Broom, Percy M. Hampshire, Frank Wade, John A. Brown, George B. Willey, Daniel Robinson, William L. Odell, Robert L. Bennett, John A. Cunningham, Oswald F. Hudson. Free Studentships for Physics and Chemistry: Victor Lough, Charles Headland, Donald J. Browne. National Scholarships for Biology: Frank Cavers, George E. Nicholls.

THE forty-fourth Report of the Department of Science and Art has just been issued. For the benefit of those who are not familiar with this Departmental publication, it may be remarked that the contents are not merely concerned with museums connected with the Department of Science and Art, and statistics and reports upon the progress of education in science and art during 1896; for appended to the volume is the report of the Director-General of the Geological Survey of the United Kingdom (for an abstract of which see p. 178), and also the Report of the Committee on Solar Physics. The number of students under instruction in Science and Art Department Classes in 1896 was 196,185; these were distributed among 10,500 classes in 2583 separate schools. It is satisfactory to learn that practical instruction in science is making progress; but some little time must elapse before sufficient laboratories are provided to enable all students in Departmental schools to perform the experimental work, without which scientific teaching is of no value. The efficiency of the practical instruction given in certain science subjects is now judged by inspection and not by examination. This should encourage the practical side of science instruction, and prove of great benefit to the students and the teachers. In evening classes as much cannot be done in the development of this kind of instruction as in classes in day schools, but even in these a good beginning has been made in some few cases. It is announced in the Report that it is proposed to divide the Honours stages of the various science subjects into two parts, the first part being intermediate in difficulty between the advanced stage and the second part of Honours. It is also announced that a new syllabus is in preparation to form part of the present elementary stage of biology, and be a preparatory study for biological science in the same way that the new section of the elementary stage of physiography is for physical science.

THE Glasgow University Court has sent us a memorandum referring to the disciplinary or penal powers of the qualifying medical authorities. Upon several occasions the General Medical Council has occupied itself with the question of the expediency of obtaining further disciplinary powers, especially as regards the Universities, to be exercised by the qualifying medical authorities over those to whom they grant diplomas entitling the holders of them to be admitted to the *Medical Register*. It was pointed out by the General Medical Council a year ago that there are six Universities which do not possess any disciplinary powers, and that there are in addition two Universities which possess only partial or limited disciplinary powers over their graduates. The result is this, that however gross the misconduct of a graduate may be, whether as a convicted felon, or declared by the General Medical Council guilty of infamous conduct in a professional respect, for which his name has been removed from the *Medical Register*, he still retains the degree and the title conferred upon him by any one of these Universities. Such a state or condition of matters must cause very considerable regret to the authorities of the University which has conferred the degree, and which it has no power to cancel. The association of their names with such black sheep amongst them must also cause much regret to be felt by the graduates, and must lead them to feel how desirable it is that the authorities of the University should obtain powers to take away degrees which are thus discredited. The Scotch Universities' Commissioners have been appealed to, but they have decided that they have no power by ordinance to alter the status of any graduate, or to confer upon the Universities powers which they do not already possess as regards deprivation in cases of discreditable conduct or proved legal offence. The Privy Council has, however, expressed a desire to aid in the matter, and has indicated that further powers might be obtained by statute, or, in the case of the Scotch Universities, by ordinance. The Glasgow University Court has, therefore, asked the Universities' Commissioners to again consider the question, and to obtain the opinion of all the Scottish Universities upon it, so that their final report may assist in bringing the Universities in line with each other, and satisfy the wish of the General Medical Council.

SCIENTIFIC SERIALS.

American Journal of Science, August.—*Tamiobatis vetustus*, a new form of fossil skate, by C. R. Eastman. The only remains of this fish are a skull found in Powell County, Kentucky; exact site unknown. It is embedded in a greenish-grey limestone of a talcose structure, probably Middle or Upper Devonian. The skull presents some features that are shark-like, and differs notably from the skulls of existing rays. It indicates a very generalised condition, and it is impossible to assign it to any known genus or family, but there are resemblances to the Rhinobatidæ.—The Florencia formation, by O. H. Hershey. This is an ancient stream gravel of North-western Illinois, consisting largely of galena limestone derived from Pleistocene rock gorges.—Native iron in the coal measures of Missouri, by E. T. Allen. Native iron was found at Cameron, Weanbleau, and Holden, Missouri. It was found in every case at such a depth from the surface, and under such conditions, that there can be no doubt as to its terrestrial origin. Besides, the specimens contained no nickel, which is always associated with meteoric iron. In Cameron, Clinton Co., it was found as a vein five or six inches thick, embedded in sandstone at a depth of fifty-one feet.—On Bixbyite, a new mineral, and on the associated topaz, by S. L. Penfield and H. W. Foote. The mineral is found very sparingly on the edge of the desert, about thirty-five miles south-west of Simpson, Utah. The crystals, which are brilliant black, and of metallic lustre, are implanted upon topaz and decomposed garnet and rhyolite, and have evidently been formed by fumarole action. The composition is essentially $FeO.MnO_2$.—The separation of aluminium and beryllium by the action of hydrochloric acid, by F. S. Havens. This method is based upon the fact that the hydrous aluminium chloride $AlCl_3.6H_2O$ is practically insoluble in a mixture of strong HCl and anhydrous ether saturated with HCl gas. The beryllium is determined by weighing as oxide after conversion to the nitrate and ignition.

Bulletin of the American Mathematical Society (June).—"James Joseph Sylvester" is the title of an address delivered by Dr. Fabian Franklin at a memorial meeting at the Johns Hopkins University (May 2). This is an appreciative estimate of the genius of a man whose death "deprived Mathematical Science of a most brilliant mind, and the scientific world in general of one of its foremost workers" (NATURE, March 18, p. 468; *cf.* also March 25, pp. 492–94). Dr. Franklin closes with the remark that "his work, brilliant and memorable as it was, affords no true measure of his intellectual greatness. Those who came within the sphere of his personality could not but feel that, through the force of circumstances, combined with the peculiarities of his poetic temperament, his performance, splendid as it was, has not adequately reflected his magnificent powers. Those of us who were connected with him, cherish his memory as that of a sympathetic friend and generous critic. And in this university, as long as it shall exist, he will be remembered as the man whose genius illuminated its early years, and whose devotion and ardour furnished the most inspiring of all the elements which went to make those years so memorable and so fruitful."—Mr. C. H. Hinton, in Hyperbolea and the solution of equations, communicates some interesting remarks on the system of mathematics in vogue in Hyperbolea, and shows that a consideration of the methods of the Hyperboleans leads to a

graphical representation of quantities of which, given an appropriate train of mechanism, not only the real, but also the imaginary roots of an equation can be mechanically found. The author thus defines the locality of Hyperbolea as being a land in which distance is measured by the function $\sqrt{x^2 - y^2}$. —Lie's geometry of contact transformations is a full and useful analysis (pp. 321–350), by Dr. E. O. Lovett, of the Geometrie der Berührungstransformationen of Lie and G. Scheffers (1° vol. Leipzig, 1896).—Dr. M. Bôcher shortly reviews "Plane and Analytic Geometry," by Messrs. F. H. Bailey and F. S. Woods, and concludes that the book deserves praise, not only for clearness of statement, but in the main for rigour of treatment.

Wiedemann's Annalen der Physik und Chemie, No. 8.—Series spectra of oxygen, sulphur, and selenium, by C. Runge and F. Paschen. The three spectra show a regular structure. The lines may be joined in series which obey the laws found by Rydberg and by Kayser and Runge. There is also a regularity of transition from one spectrum to another. As the atomic weight increases, the spectrum as a whole travels towards the region of greater wave-lengths, as has also been found in the case of other allied elements.—Irreversible processes, by O. Wiedeburg. The reversible process in thermodynamics cannot be practically realised, since some of the operations would have to take place in an indefinitely long time, and others in an indefinitely short time. The author attempts to discover a general treatment of irreversible processes, and begins by separating intensities, quantities, resistances, and energies. An advantage is gained, inasmuch as heat and other forms of energy can be treated by the same equations.—Electrolysis of rarefied gases, by E. Wiedemann and G. C. Schmidt. Gaseous hydrochloric acid is subjected to the action of a certain quantity of electricity in a vacuum tube. The chlorine separated is collected by means of mercury. The result of a series of experiments is that only about 53 per cent. of the theoretical quantity of chlorine due to the current is separated, 31 per cent. being separated at the anode, and the rest at the kathode. Mercury haloids gave less than 6 per cent. Electrolysis of gases is therefore different from that of liquids, and does not obey Faraday's laws.—Magnetic behaviour of soft steel, by Anton Abt. Soft Martin steel is as useful for electromagnets as soft iron, when no rapid alternations are called for. The permeability is about the same, and the permanent magnetism is only about 25 per cent. higher.—Determination of capacities by the balance, by V. von Lang. A coil carrying an alternate current is balanced over another, which is in circuit with a condenser. The difference of phase between the two coils, and hence also the attraction between them, is a function of the capacity of the condenser. The attraction is compensated by weight.—Dielectric constants of solids, by H. Starke. The method described of immersing a fragment of the solid in a mixture of two liquids of widely different dielectric capacities, and adjusting them to that of the solid, is greatly simplified by employing the rapidly alternating currents of Nernst's differential exciter. The conductivities of the liquids no longer interfere with the results.

Bollettino della Società Sismologica Italiana, vol. ii., 1896, Nos. 9 and 10.—Comparative study of two normal tromometers differently mounted, by S. Arcidiacono.—The photographic tromometer, by G. Agamennone.—Description of an apparatus for registering microseismic movements, by G. Mugna.—Notices of earthquakes recorded in Italy (Sept. 9–Dec. 31, 1896); the more important being the earthquakes of Livorno (Nov. 29), Frignano (Dec. 8), and the Province of Pisa (Dec. 25), and distant earthquakes of unknown origin on Oct. 30, Nov. 1, 5 and 10. There is no record of the Hereford earthquake of Dec. 17.

Vol. iii., 1897, No. 1.—The seismic period of Epirus in Jan. 1897, by G. Agamennone. — Relation between the frequency of earthquakes and their intensity, by F. de Montessus de Ballore (in French). An attempt to show that the frequency of earthquakes in a district is a fair measure of its seismic activity if the number of years over which the record extends is great, so that, in estimating the activity, the intensity of the shocks may be left out of account.—On a type of seismometrograph for photographic registration, by G. Agamennone.—Notices of earthquakes recorded in Italy (Jan. 1–Feb. 4, 1897), by G. Agamennone; the more important being the earthquakes of Umbria (Jan. 6–7, 19), Persian Gulf? (Jan. 10–11), and Venetia (Jan. 27), and a distant but unknown earthquake on Jan. 3–4.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 9.—M. A. Chatin in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Tholozan, Correspondant in the Section of Medicine and Surgery. He also announced the sudden death of Prof. Victor Meyer at Heidelberg. —On the number and symmetry of the ligneous bundles of the appendices (leaves) in their relation to organic perfection, by M. Ad. Chatin. A classification is given according to the number of bundles in the petiole.—On the crystalline form of the chloroplatinates of the diamines, by M. J. A. Le Bel. Measurements are given of the axial ratios for a large number of chloroplatinates of amines of the type $NH.R_1R_2$, where R_1 and R_2 may be any pair of the methyl, ethyl, normal or isopropyl, normal butyl, or amyl groups.—On some ketonic ethers, by M. A. Collet. By the action of a bromo-ketone upon an alcoholic solution of potassium acetate, the acetic ethers of phenyl (α)-hydroxypropyl ketone, phenyl-(α)-hydroxy-ethyl ketone, and phenyl-(α)-hydroxyisopropyl ketone were prepared in the pure state.—Products of the hydrolysis of starch by diastase, by M. P. Petit.—On a theoretical point in dyeing, by M. Léo Vignon. From the results of the experiments given that the cause of the fixing of substantive colours by cotton is of a chemical order, the nitrogen in the substances added becoming pentavalent. An experiment with the three bases $(C_6H_4)_2(NH_2)_2$, $(C_6H_4)_2(N(CH_3)_2)_2$, and $(C_6H_4)_2[N(CH_3)_3I]_2$ directly confirmed this, since cotton absorbs from six to seven per cent. of the first two bases, but practically none of the third.—On a new alkaloid, by MM. Battandier and Th. Malosse. The alkaloid is extracted from the young branches and the bark of *Retama sphærocarpa*, and hence is termed Retamine, a kilogram of the fresh plant giving about four grams. Its composition appears to be given by the formula $C_{15}H_{26}N_2O$.—On the presence of *Pseudocommis vitis* (Debray) in the stem and leaves of *Elodea canadensis*, by M. E. Roze.—On an acarus of the vines of Grenache (*Carpoglyphus passularum*, Rohin), by M. E. L. Trouessart.—On the root of *Suæda* and *Salsola*, by M. Georges Fron.—On the assimilating tissue of stems deprived of leaves, by M. Auguste Boirivant. The suppression of the leaves in a plant gives rise to a deeper green colour in the stems or petioles, due to the production of a larger number of chlorophyll grains than the normal. There is also a modification in the form of the cell of this tissue, the cells being lengthened radially, and the number of cell layers containing chlorophyll is increased.

CONTENTS.

THURSDAY, AUGUST 26, 1897.

OUR COAL RESOURCES.

Our Coal Resources at the Close of the Nineteenth Century. By Edward Hull, LL.D., F.R.S. Pp. xii + 157. (London: E. and F. N. Spon, Ltd., 1897.)

IT will be a matter of sincere regret to all mining students to learn from the preface to this work that when in 1895 the last copies of the fourth edition of Prof. Hull's "Coalfields of Great Britain" were sold out, the publisher decided not to issue a new edition. This want of enterprise obliges students to content themselves with perusing the well-thumbed copies in our public libraries. Fortunately, however, the author has now written a supplementary volume dealing with investigations into the coal resources of the British islands, and bringing the statistical information contained in the original volume up to date.

The question of the duration of our coal supplies has not lost any of its interest since the publication in 1860 of the author's reassuring statistics, and since the issue of the report of the Royal Commissioners in 1871. The annual output of coal in this country, which when the Commissioners first met together did not exceed a hundred million tons, has now risen to nearly double that quantity, and the process of exhaustion still continues. Clearly, therefore, the author is well advised in regarding the close of the nineteenth century as a fitting occasion for taking stock of the British coal resources upon which so much of the commercial prosperity of the Empire depends. In his estimates of the individual coalfields of Great Britain, the figures of the Royal Commission have been adopted, after making deductions for quantities credited to seams under two feet in thickness, which ought, in his opinion, to have been omitted from the calculations of the Commissioners. Modifications have also been necessary in estimating quantities outside the visible coalfields in areas concealed beneath the Permian and Triassic formations. Moreover the quantity extracted from 1870 to 1895, and the estimated quantity from 1896 to 1899 have been deducted so as to give the resources available at the end of the century. The total estimated quantity of coal within a depth of 4000 feet remaining at the close of the century is thus found to be 81,683,000,000 tons, the quantity remaining in the visible coalfields of Great Britain and in partially concealed areas being 58,275,700,000 tons, that in the entirely concealed areas 23,253,000,000 tons, and that in Ireland 155,300,000 tons. Unfortunately the production of the Irish coalfields is too insignificant to have anything beyond a local interest. The author points out, however, that in County Tyrone there is a tract extending to the borders of Lough Neagh overspread by Triassic and Tertiary strata under which a valuable coalfield may be supposed to lie.

In ten chapters the different English, Welsh and Scottish coalfields are discussed in detail. With regard to coal south of the Thames, the author takes a hopeful view of the future of the Kent coalfield. It may now, he says, be accepted as geologically certain that between Dover and Bath there occurs a more or less interrupted trough of coal measures of 150 miles in length and of a breadth varying from two to four miles. An interesting chapter is that devoted to the position of the various coal areas as regards the magnitude of the output, classified as progressive, stationary, or retrogressive. In the last case this character is a certain sign of approaching exhaustion. The author's classification is as follows:—

I. *Progressive Coal Areas.*—1, South Wales and Monmouthshire; 2, North Midland district; 3, Scottish group; 4, Lancashire and Cheshire group; 5, Great Northern district; 6, Denbighshire; 7, Warwickshire; 8, Cumberland (slightly); 9, Leicestershire (slightly).

II. *Stationary Coal Areas.*—1, Bristol and Somersetshire; 2, Forest of Dean.

III. *Retrogressive Coal Areas.*—1, South Staffordshire; 2, Flintshire; and 3, Coalbrook Dale.

The last forty pages of the volume are devoted to an inquiry into the approximate limit of deep mining and to the production of foreign coalfields. A great many of the difficulties which were formerly connected with the sinking of deep shafts have now disappeared. The chief impediments are the increase of temperature and the increase of pressure. In discussing the former obstacle, the author might have cited more recent observations than those made in 1848 at the Dukinfield Colliery, and in 1854 at Rose Bridge Colliery. Methods of determining earth temperatures have greatly improved since those dates; and the results recently obtained at the Paruschowitz borehole (where observations made at a depth of 6573 feet showed an increase in temperature of 1° F. for every 62·1 feet), and at numerous other boreholes and mines, details of which were given in a paper read before the Society of Arts last year by the writer of this notice, afford more conclusive evidence of the depths at which mining is possible.

Throughout the work the author takes a highly optimistic view of the future of British coal-mining. Thus on p. 9 he says: "Notwithstanding the development of the coalfields of foreign countries, which has been considerable during the last quarter of a century, British coal, owing to its superior quality, still holds its own." This view characterises the entire work, and the growth of foreign competition is ignored. Yet statistics show that whereas Great Britain in 1840 produced 75 per cent. of the world's supply of coal, at the present time it produces only 34 per cent. Atlantic liners no longer carry coal from Great Britain for the return journey; they now take in American coal, and no less than one and a half million tons of American coal were thus consumed in 1895. The author rightly points out that the condition of the iron manufacturing industries has always exercised a most important influence on the production of coal, so that a large demand for iron draws with it a large demand for mineral fuel. He does not tell us, however, that during the last twenty-five years the world's production of pig-iron has increased from twelve to twenty-six million tons; but the share taken by Great Britain has fallen from 48·8 per cent. to 29 per cent., whilst that of the United States has increased from 14·1 per cent. to 26·2 per cent., that of Germany from 11·4 per cent. to 21·4 per cent., and that of Russia

from 3 per cent. to 4·7 per cent. Indeed, iron is now being imported from the United States into this country; and, incredible as it may seem, the railway station at Middlesbrough, the centre of the iron trade, is built of iron brought from Belgium. Surely, then, the author is hardly right in thinking that British coal and iron still hold their own. He argues that other countries of Europe are exhausting their coal supplies just as Great Britain is, yet the figures he gives show that Germany has in reserve, within a depth of 3000 feet, 109,000 million tons of coal, as compared with our 81,683 million tons within a depth of 4000 feet. And this estimate does not include brown coal, of which Germany raises twenty-five million tons annually.

Slight errors in the spelling of names of persons and places suggest that the volume has been hastily written, as does the reference on p. 121 to "the second edition of this work." Moravia (p. 133) is included in Germany, Sir Courtenay Boyle is styled Mr., and among the names misspelt are Baron von Berlepsch (p. 151), Teruel (p. 134), Pocahontas (p. 135), and Ural (p. 133). These, however, are insignificant blemishes in an excellent work that may, without hesitation, be warmly recommended to all desirous of studying the questions of national importance upon which it throws so much light.

BENNETT H. BROUGH.

CHAPTERS IN THE HISTORY OF MAN.

Prehistoric Problems. By Dr. R. Munro. Pp. 371. 8vo. 150 figs. and 8 plates. (Edinburgh and London: W. Blackwood and Sons, 1897.)

DR. MUNRO has done well to reprint and extend the essays which form the greater part of his newly-published "Prehistoric Problems," as anything that comes from his pen is sure to be sound in manner and matter.

The chief feature of interest in the first chapter on the rise and progress of Anthropology is a discussion concerning the gap between the Palæolithic and Neolithic periods, upon which so much stress has been laid, and which several archæologists are now endeavouring to bridge over. Undoubtedly in most parts of Europe this *hiatus* is well marked, and as analogous gaps in systematic zoology and palæontology are acknowledged to be due solely to the "imperfection of the record," so the non-discovery of intermediate finds in archæology is a logical explanation of the apparent break. The transition must have occurred over large areas, and, indeed, M. Ed. Piette claims to have discovered this transition in the deer- and snail-shell layers of the cave of Mas-d'Azil; and MM. Cartailhac and Boule have found similar evidence in the cave of Reilhac. Mr. Arthur J. Evans also ascribes the famous remains of the Balzi Rossi caves of Mentone to an earlier Neolithic stratum than any of which we have hitherto possessed authentic records. Dr. Munro takes up the running with a description of the bone and deer-horn harpoons found in various European caves. He finds that a particular type of these implements occurs from the Pyrenees to Scotland (Oban), and though all the records are not very satisfactory, yet they indicate a stage of culture which appears to belong to this transitional period.

In the second, third, and fourth chapters the author attempts "to correlate the phenomena of man's environments with the corporeal changes necessitated by his higher intelligence, and to place a summary of the results before general readers." Dr. Munro emphasises the mechanical and physical advantages accruing from the erect posture and from the differentiation of the limbs into hands and feet; these facts have long been recognised by anatomists, but it is well to have them clearly stated in non-technical language for the general public.

"With the advantage of manipulative organs and a progressive brain (which was rendered possible only by the attainment of the erect position and the evolution of the limbs), the precursor of man became *Homo sapiens* and gradually developed a capacity to understand and utilise the forces of nature."

Neither in his physical structure nor in his mental or moral attainments does Dr. Munro recognise any other process than a gradual transformation. The evolution of bipedal locomotion

"being mechanically advantageous and readily effected according to the laws of morphological adaptation had a short duration. The transformation during which his mental organisation developed to the extent of becoming a new governing force in the organic world was an extremely slow process, and consisted of infinitesimally small increments of knowledge, acquired by repeated experiences of reasoning from cause to effect and from means to ends."

Dr. Munro brings osteological and craniological evidence in support of his views, notably that supplied by our now old friend *Pithecanthropus erectus*.

In the archæological portion of the book are four chapters on "Prehistoric trepanning and cranial amulets," "Otter and Beaver traps—a strange chapter in Comparative Archæology," "Bone-skates and their archæological range in Europe," and "Prehistoric saws and sickles," all of which exemplify Dr. Munro's sound archæological methods of investigation.

The essay on trepanning is of considerable interest, as it illustrates how craniology may throw light upon the surgical and religious practices of prehistoric folk. Quite a large number of skulls have now been found which exhibit artificial orifices, usually rounded or ovoid, which were made either when the patient was alive, as is proved by the healing that has occurred on the cut edges of the bone, or after death; in some cases it can be proved that the patients did not survive the operation, or perhaps died from the illness that the trepanning was intended to cure. The trepanning was probably performed in most cases by scraping the head with a piece of flint; sometimes a fragment of bone was cut out bodily. Any part of the cranium, except the forehead, was operated upon. It is supposed that, in the majority of cases, the primary object of the operation was to cure or alleviate "some mental disorder of an epileptiform character."

Undoubtedly relief was obtained as so many people were operated upon, and since the pieces of the skull so obtained were worn as amulets by the living and sometimes buried with the dead. It is not absolutely proved that all cranial amulets were exclusively derived from trepanned skulls; one or two pieces of bone, evidently used as amulets, have been found made from other human bones. It is worthy of notice that most of the trepanned skulls belong to the Neolithic or Early Bronze age, and

the majority of them are dolichocephalic. The custom is still in full use among the hill tribes who live in the south-east corner of the Algerian plateau, and it is also reported from Montenegro; there are also traces of it in America.

The evolution of the saw is ably treated by Dr. Munro, who is careful to point out the permanence of shapes of implements, the early bronze saw being a direct copy of the antecedent flint saw.

There is no need to further emphasise the fact that Dr. Munro has produced a book which, though designed for the general reader, contains a good deal of new matter, and is a serious contribution to several important aspects of archæology. It seems ungracious to pick out minor points for criticism, but it is desirable to distinguish between "rudimentary" and "vestigial" organs; those mentioned on p. 21 belong to the latter category. It is a pity to retain the name of "Bâton de commandement" (pp. 43, 49, 51) for objects which, judging from modern analogues, were in all probability arrow- or javelin-straighteners.

A. C. H.

OUR BOOK SHELF.

The Tutorial Trigonometry. (The University Tutorial Series.) By William Briggs, M.A., and G. H. Bryan, F.R.S. Pp. viii + 326. (London: W. B. Clive, Univ. Corres. Coll. Press, 1897.)

IN this school-book of three hundred and twenty-six pages the authors have arranged a course on trigonometry which should be most useful to those studying this subject for the first time. The book may be roughly divided into three portions, dealing first with the trigonometry of one angle, then with that of two or more angles, and, lastly, with logarithms and the trigonometry of triangles. This arrangement seems to work out well, as it allows of the formation of a simple progressive course. The authors rightly lay some stress on the insertion of illustrative exercises, and many of these will be found in the text. In the chapter devoted to the trigonometric functions of a variable angle special attention has been drawn to the tracing of the curves, so that the reader is here introduced to a method which is of great importance not only in this, but in other subjects.

By a judicious arrangement of different sizes of type the comparative importance of the subject-matter, and also the fundamental formulæ, can be easily observed at a glance. Numerous figures and examples are attached to each chapter, the answers being brought together at the end of the book.

As a course for schools, and for those who are working up the subject by themselves, the book can be recommended.

W. J. S. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"Species or Subspecies?"

THE article by Mr. Lydekker with the above title, in your issue of July 15, deserves some comment. The writer appears to think that the "lumpers" have gained a point; but his attitude, while professing to be a "lumper," shows how much progress the cause of the "splitters" has made in the last few years. It was not formerly a question of "species or subspecies?" at all, but whether what Mr. Lydekker would now call subspecies should be recognised at all in the nomenclature. Dr. Merriam's excellent researches have brought to light a great number of geographical races of our mammals, which were in former years deliberately ignored. It is true that the older naturalists never possessed anything like such good series of specimens as he has had before him, but it is safe to say that even if they had possessed Dr. Merriam's material, they would have despised or overlooked many or most of the facts which could be deduced from it. When species were supposed to have been created separate, it seemed evident that minor divisions were comparatively of no account, and had nothing to do with real species whatever. At the present time, we recognise the fact that there must be every gradation between individual variations and specific characters, and the whole series of phenomena deserves our attention. The study of subspecies, of variations, and of individuals, are all part of the necessary work of the modern naturalist, and there arises the necessity for a nomenclature applicable to each branch or division of the general subject.

It is comparatively immaterial whether closely allied forms are called species or subspecies. What is important is that they should be differentiated and named. Now that even "lumpers" are apparently ready to recognise the facts in the nomenclature, "splitters" should consider their convenience as far as may be possible. It is certainly true that while the breaking up of the old generic and specific groups leads to better and clearer ideas of the facts of nature, these facts can be expressed just as well by the use of subgeneric and subspecific names as by the excessive multiplication of "genera" and "species." If, then, it is found that concessions can be made to non-specialists without any real loss of precision and detail, surely they should be made. The result will be to aid the outsider, without really inconveniencing the specialist.

At the same time, it is quite impossible to so arrange matters that terms of the same rank shall always express groups of equal value. In some genera the groups we must necessarily call species are much less distinct than those of other genera. In Jamaica, for example, as was long ago pointed out by C. B. Adams, the species of land shells are not as distinct as they are in England, and yet if "lumped" would give us "specific" aggregates which would be absurdly large and varied, not comparable at all with what we commonly understand as species. In other countries, *e.g.* Italy, we find well-marked species with numerous local subspecies. The three different conditions can be represented as below, the dots representing the specific or subspecific units.[1]

English land shells: . . . . . .
Jamaica land shells: . . . .
Italian land shells: ....

Again, it would be quite absurd to refuse to recognise species which can only be separated by the specialist. There are thousands of perfectly distinct species which an ordinary "layman" would confound. Mr. Lydekker seems to realise this when he thinks of the rodents; for as he well knows, there are not only distinct species, but quite distinct genera of these animals which are popularly confounded, and many cannot even be recognised off-hand by the specialist. No zoologist would have the courage to recommend a classification of the Rodentia, based on the differences observed by ordinary persons, as thus:—

Genus 1. Mouse.
 Species 1. House mouse.
 2. Dormouse.
 3. Field mouse.
Genus 2. Rat.
 Species 1. Brown rat.
 2. Black rat.
 3. Water rat.

T. D. A. COCKERELL.

Mesilla, New Mexico, U.S.A., July 31.

Distant Sounds.

Is it not possible that the sound of distant firing, mentioned by Mr. C. Mostyn in his letter in NATURE (p. 248), may be the same kind of phenomenon as is described in the *Annalen der Hydrographie und Maritimen Meteorologie*, 1897, p. 160, and is called "Mistpoeffers"?

F. L. ORTT.

The Hague, August 11.

[1] In each class, a number of smaller dots might be added, if we desired to recognise what are commonly called varieties. Varietal nomenclature is not here considered, but it obviously is a necessity for students of evolution and variation, to whom a variety is often of more interest than a species. In discussing certain classes of cases, *e.g.* breeds of domestic animals, names are often required for individuals.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

V.

The Spectrum of the Corona.

I HAVE already stated that one great advantage possessed by the prismatic camera is that it has enabled us to distinctly separate the spectrum of the corona from that of the chromosphere. It has done this because the coronal radiations are *not* most intense near the prominences.

The following reproduction (Fig. 19) of a photograph, recently published by the Royal Society, will show how clean cut the distinction is. A nearly complete ring is shown in 1474 light, while the H and K light only provides us with dots showing the positions of the brightest prominences.

It is seen at a glance that while the greatest intensities of the H and K light occupy similar positions, the *loci* of greatest intensity in the case of the 1474 light are widely different in position; that is, they do not occupy the same positions as the rings assumed perfect. Careful study shows that the 1474 ring marks out the brightest parts of the corona, and neglects the chromosphere and prominences altogether.

Except in the case of the ring in the green at 1474 of Kirchhoff's scale the coronal rings are very feeble, and hydrogen, have not previously been recorded by the prismatic camera, though some of the lines corresponding to them appear to have been photographed with slit spectroscopes. The rings photographed in 1893 are compared in the following table with the results obtained by the slit spectroscopes in the years 1882, 1883, 1886,[1] and 1893,[2] those lines only which are possibly common being included.

Prismatic camera. 1893. λ R.	Slit spectroscopes. 1893 λ A°.	Slit spectroscopes, 1886. λ A°.	Slit spectroscopes, 1883. λ A°.	Slit spectroscopes, 1882. λ A°.
3987	3986·4	3985·0 (1)[3]	3986 ?	
4086	...	4084·2 (4) 4089·3 (4)	} 4085	4085
4217	...	4216·5 (3)		
4231	...	4232·8 (5)		
4240	...	4241 (4)	...	4241
4280	4279·7	4280·6 (4)	4279	
4486	...	4485·6 (3)		

We see then that all the coronal radiations above referred to probably correspond with lines photographed by Dr. Schuster in 1886. The intensities, however, are not the same.

The number of coronal rings recorded with the prismatic camera is very much smaller than the number of lines attributed to the corona photographed with the slit spectroscopes in this and previous eclipses. This is, no doubt, partly due to the rings being submerged in continuous spectrum, which is relatively more intense in the case of the prismatic camera. Further, as already pointed out, it is not yet established that many of the lines recorded as being due to the corona by the slit spectroscopes are not due to glare.

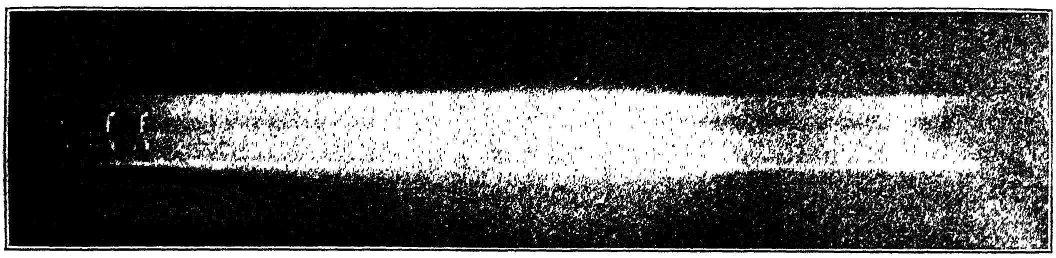

FIG. 19.—The 1474 light ring compared with the prominences as depicted in H and K light during the eclipse of 1896.

their wave-lengths can, perhaps, not be depended upon to within one-tenth metre. They were read off from the African negatives by direct comparison with the spectrum of Arcturus. Possibly, owing to the great intensity of the continuous spectrum, the Brazilian negatives show only the green ring.

The wave-lengths of the coronal radiations are as under, the numbers following them indicating the number of African photographs in which they have been detected.

Wave-length, Rowland.	
3987	(6)
4086	(4)
4217	(2)
4231	(5)
4240	(1)
4280	(2)
4486	(3)
{ 5316·9 1474 K	(5)

It is almost impossible to form any trustworthy estimate of the relative intensities of the rings, but it may be noted that the one at wave-length 3987 comes next to 1474 K in order of brightness. There are indications of other extremely faint rings, the positions of which cannot be determined with the necessary degree of accuracy to enable a useful statement to be made touching their wave-lengths.

Coronal rings, other than those due to 1474 K, or

By a comparison of the results obtained with slit spectroscopes and prismatic cameras, it would seem to be possible to determine which of the lines recorded by the former instruments really belong to the coronal spectrum. The most intense light will give the strongest glare, and therefore the brightest lines of the chromosphere and prominences will become superposed on those due to the corona. As the results obtained with the prismatic cameras are so very definite with regard to the spectrum of the prominences, it seems only necessary to subtract the common lines of the spectra recorded by the two instruments from the total number recorded by the slit spectroscopes in order to determine those which certainly belong to the corona.

An attempt has been made to investigate the coronal spectrum in this way by reference to the slit spectra of 1886 and 1893, but no satisfactory results can be obtained in this way until slit spectra taken with greater dispersion become available.

[1] Continued from page 368.

[1] *Phil. Trans.*, 1889, A, p. 335. [2] *Roy. Soc. Proc.*, vol. 56, p. 20.
[3] Intensity on a scale where 6 = brightest line.

In the case of the rings photographed in 1893, the evidence that they truly belong to the corona is absolutely conclusive. In the absence of more exact knowledge of the wave-lengths of the radiations producing the rings, it is not yet possible to determine if they are represented by dark lines in the Fraunhofer spectrum, but it can already be stated that, if present at all, they are among the feeble lines.

A point of some importance is the apparent absence of the 1474 K ring from the spectra of the chromosphere and prominences. Its absence from the prominence spectrum was noted by Respighi in the eclipse of 1871. I am not aware of any observation in which the *form* of a prominence has been observed in 1474 light. All these facts seem to indicate that when the 1474 line is observed at the sun's limb without an eclipse, the spectrum of the corona itself is under examination, under the same conditions as those recorded in the eclipse photographs.

Of the other coronal rings photographed in 1893, those at wave lengths 4217 and 4280 are approximately coincident with feeble prominence radiations, but since the other coronal rings are not represented in the prominences, the coincidences may be regarded as accidental.

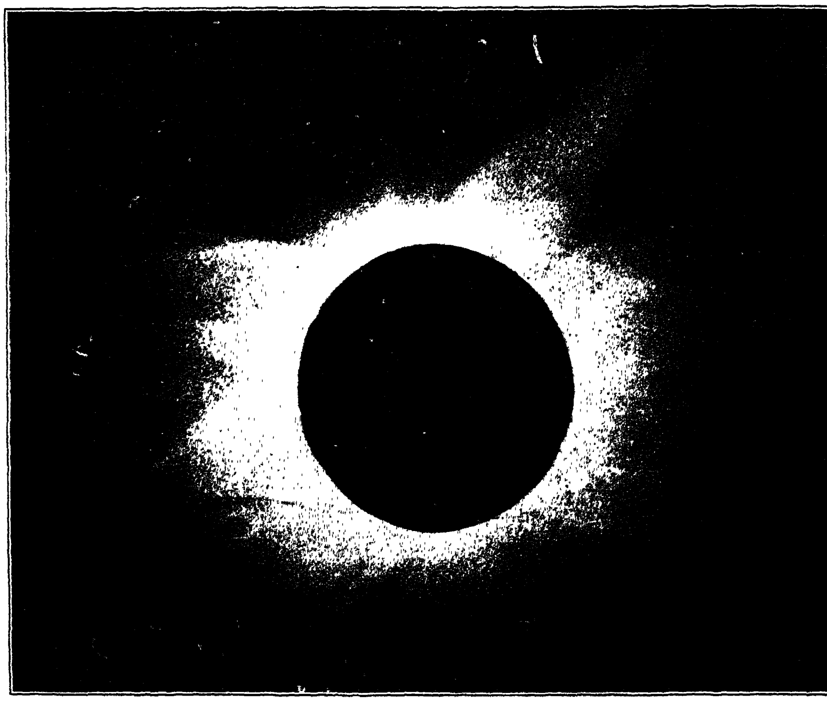

FIG. 20.—The Corona of 1896, Kostinsky.

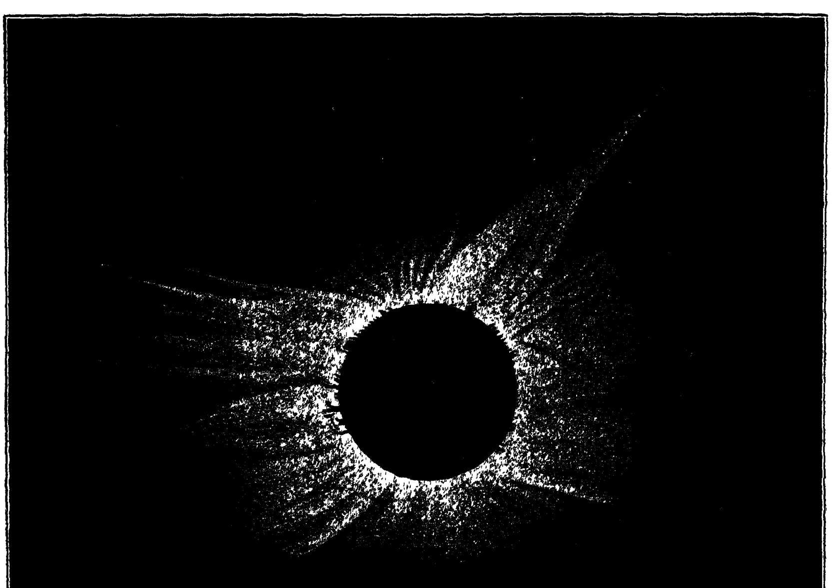

FIG. 21.—Drawing bringing together all the details shown on Kostinsky's and Hansky's photographs. (Prominences shown in black.)

Although H and K are by far the most intense of the radiations of the prominences, on no occasion have they been photographed as rings in the spectrum of the *corona* with the prismatic cameras. They have, however, been occasionally recorded as corona lines with slit spectroscopes, but it does not seem improbable that in most cases they were produced by prominence light, scattered by our atmosphere, as before explained—light of which the prismatic camera takes no account.

Perhaps the most decided evidence in favour of the existence of H and K in the corona spectrum is that depending upon the photographs taken with slit spectroscopes in 1886; Dr. Schuster states that "the lines end sharply with the corona, and we must conclude, therefore, that in spite of the unfavourable atmospheric conditions, there was but little light scattered by our own atmosphere in the neighbourhood of the sun." But in spite of this observation, Dr. Schuster has concluded that H and K "do not form part of the normal spectrum of the corona";[1] and I may add that the prismatic camera strengthens this conclusion.

The photographs taken with the prismatic cameras in 1893 show a pretty strong "continuous" spectrum, but it has already been explained that this appearance may have been produced by a very

[1] *Phil. Trans.*, vol. 180, A, p. 341.

complicated spectrum, such as that which I observed in the corona in 1882. Concerning my observations, I wrote:—[1]

"Instead of the gradual smooth toning seen, say, in

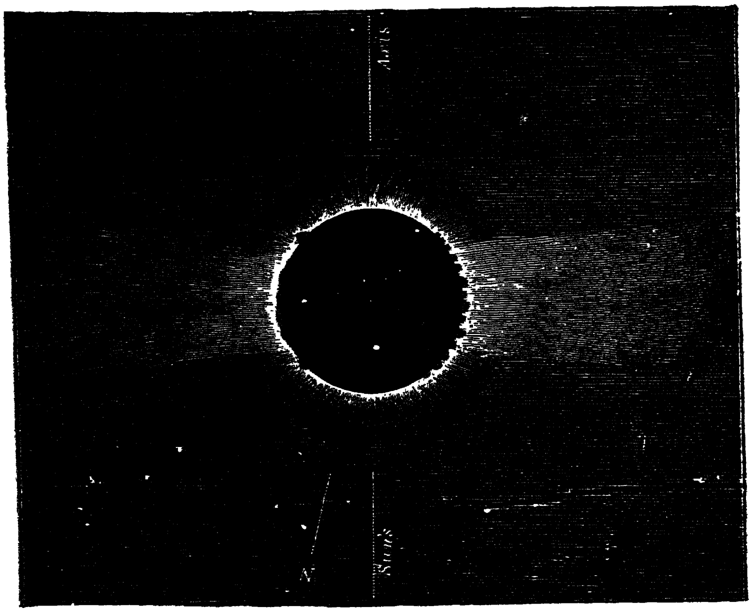

FIG. 22.—The Corona of 1867.

the spectrum of the limelight, there were maxima and minima, producing an appearance of ribbed structure, the lines of hydrogen and 1474 being, of course, over all. This observation, however, requires confirmation, for the look I had at the corona spectrum was instantaneous only."

A change in the spectrum of the corona was placed beyond all doubt in my own mind by my observations in 1871 and 1878. With reference to this I wrote as follows in 1878 (NATURE, vol. xviii. p. 460):—

"The utter disappearance of the large bright red corona of former years in favour of a smaller and white one in this year of minimum struck everybody. Indeed, it is remarkable that, after all our past study of eclipses, this last one should have exhibited phenomena the least anticipated. It isolates the matter that gives us the continuous spectrum from the other known constituents. The present eclipse has accomplished, if nothing else, the excellent result of intensifying our knowledge concerning the running down of the solar energy. On the former occasion, in 1871, the 1474 ring was very bright, but in 1878 I did not see it at all."

As the sunspot period is one of about eleven years, it was to be expected that the conditions of 1871 would be repeated in 1882 and 1893, and during both these eclipses the 1474 ring was photographed with the prismatic cameras. The photographic plates employed in 1875 and 1886 were not sensitive to the green, and, since no eye observations were made, we have no evidence as to the visibility of the 1474 ring in those years.

Although there can be no doubt as to a more or less regular change of intensity in the case of 1474 K, the evidence with regard to other radiations is less conclusive.

The Form of the Corona in 1896.

For our knowledge of the Corona as photographed in 1896, we are so far dependent upon the communication made to NATURE by Baron Kaulbars, touching the results obtained in Finland (NATURE, vol. lv. p. 298), and the important collection of memoirs communicated to the Imperial Academy of Sciences of St. Petersburg, brought together in a volume of 144 pages recently published, giving an account of the work in Novaya Zemlya and on the Amur. The volume contains some admirable reproductions of the photographs taken by MM. Kostinsky and Hansky at Malya Karmakouly in Novaya Zemlya. A copy of M. Kostinsky's second photograph exposed during ten seconds is given here (Fig. 20).

In a *drawing* MM. Kostinsky and Hansky have brought together all the details they have been able to trace on their negatives, as well as the positions of all the prominences observed (these are shown in black for greater clearness) (Fig. 21).

It is certainly very fortunate that these photographs of the corona, together with the still unpublished one obtained by Sir George Baden Powell, were secured, since they support statements made now many years ago touching the change of form of the corona, as well as its spectrum, in relation to the sunspot period (see my "Chemistry of the Sun" (1887), pp. 438 *et seq.*).

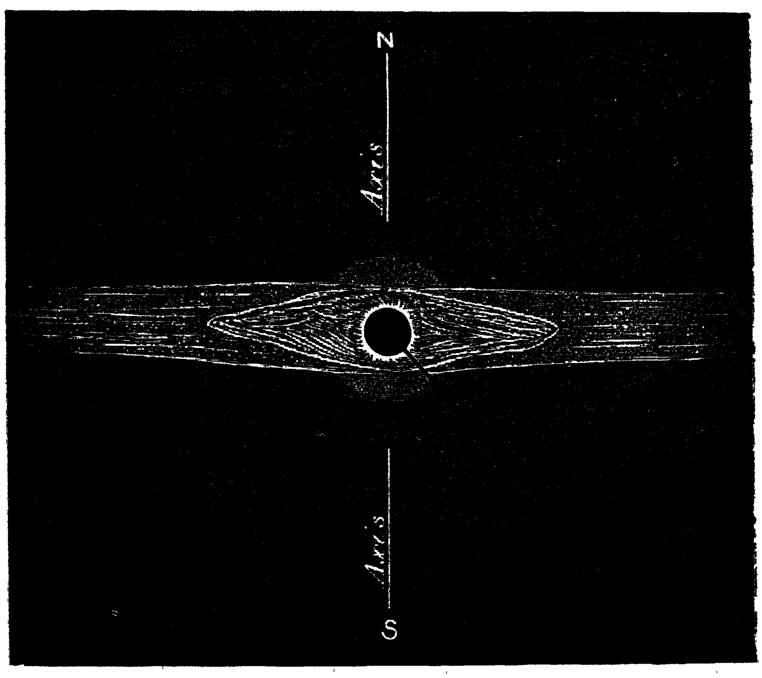

FIG. 23.—The Corona of 1878, as observed by Newcomb by means of a disc.

[1] *Roy. Soc. Proc.*, vol. 34, p. 299.

If we take the simplest case first, that of minimum sunspots depending upon minimum solar activity, we then get chiefly a well-developed equatorial elongation with a marked absence of irregular streamers in mid-latitudes. In support of this, I append two drawings (Figs. 22, 23) made at the eclipses which took place in the years 1867 and 1879, years of sunspot minimum. In the second drawing, made by Prof. Newcomb, the disc is shown by which he eclipsed the brighter lower reaches of the corona, so as to give his eye the best chance of seeing feeble extensions. The pole supporting the disc was vertical, but it is shown slantwise in the illustration because it is most important to show the sun's axis upright.

At the minimum period not only are these extensions best seen, but the exquisite structure near the sun's poles is very strikingly revealed.

At and near the maximum all this is changed, and we get streamers and their separating rifts very irregularly distributed. In 1896 these irregular streamers form striking objects, and we know from the sunspot observations that the atmosphere was more than usually disturbed—more than might have been anticipated, seeing that the maximum was due to occur in 1892.

I am glad to find in the valuable collection of Russian memoirs to which I have referred an important paper by M. Hansky, calling attention to the way in which the form of the corona varies with the sunspot period. His studies entirely confirm all I have written on this subject.

NORMAN LOCKYER.

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS.

ON August 9, 10 and 11, the first International Congress of Mathematicians met in Zurich. By the morning of the 9th there were in attendance 200 members from all parts, viz.: from Switzerland, 53; Germany, 40; France, 25; Italy, 19; Russia, 18; Austria Hungary, 16; United States, 7; Sweden, 6; Denmark, 4; Belgium, England, Holland, 3 each; Greece, Portugal, Spain, 1 each. The gathering, while fairly representative of the different branches of pure mathematics, did not adequately represent applied mathematics. The meeting of the British Association in Toronto was doubtless responsible for the absence of many English mathematicians, who might otherwise have been at Zürich; but, even making allowance for this, the presence of *three* representatives of English mathematics can hardly be regarded as a sufficient recognition of the importance of the congress.

The regulations, while prescribing French and German as the official languages, make provision also for the use of English and Italian; and it is expressly laid down that in the appointment of the committee these languages shall be represented. This body, elected at the first general meeting, was therefore composed as follows:—President, Prof. Geiser; Secretaries, MM. Franel and Rudio; Hon. Secretaries, MM. Borel, Pierpoint, Volterra, E. v. Weber; Members, MM. Brioschi, Hobson, Klein, Mertens, Mittag-Leffler, Picard, Poincaré (absent), H. Weber. The principal office of the committee was to formulate the objects and methods of the series of congresses, and to give a preliminary consideration to certain matters with respect to which action must be taken by the next congress, to be held in Paris in 1900. Among these matters those of most pressing importance are the adoption of some scheme of classification of the various branches of mathematics, and the undertaking of some bibliographical work. As to the organisation of the series of congresses, it is decided that these shall meet in different countries at intervals of from three to five years. The advisability of giving continuity to the series by the establishment of some permanent central body is affirmed, but action is deferred; this question will doubtless be ripe for discussion in 1900. The most tangible object of the congress is the encouragement of the production of detailed reports on different branches of mathematics, for which so admirable a model is afforded by the Brill-Noether "Bericht über Funktionen-theorie," published three years ago. Doubtless, too, the preparation of such reports will be materially assisted, and their international character secured, by the furthering of personal relations among mathematicians of different countries, which is laid down as one object of the congress. The arrangements so admirably planned and carried out by the Zürich committee of organisation gave all possible facilities for social intercourse, beginning with an informal gathering on the evening preceding the actual meetings, and including afternoon excursions on the lake and to the top of the Uetliberg.

Tuesday was given up to the reading of papers, for which five Sections were organised, each with President, Vice-President, and Secretary. (1) "Arithmetic and Algebra," Mertens, Peano, Amberg; (2) "Analysis and Theory of Functions," Picard, Brioschi, Jaccottet; (3) "Geometry," Reye, Segre, Künzler; (4) "Mechanics and Mathematical Physics," Jung, Joukowsky, Flatt; (5) "History and Bibliography," Moritz Cantor, Laisant, Schoute. The sittings of these Sections were arranged to begin at different hours of the morning and afternoon, to meet the natural desire of members to hear as many as possible of the leaders in different subjects. Papers of special interest were those of Brioschi, "Sur une classe d'équations du cinquième degré"; Picard, "Sur les fonctions de plusieurs variables"; Reye, "Neue Eigenschaften des Strahlenkomplexes zweiten Grades"; H. Weber, "Ueber die Genera in algebraischen Zahlkörpern"; Zeuthen, "Isaac Barrow et la méthode inverse des tangentes." Moreover, addresses were delivered at the opening and closing general meetings on Monday and Wednesday mornings by Poincaré, "Sur les rapports de l'analyse pure et de la physique mathématique"; Hurwitz, "Entwicklung der allgemeinen Theorie der analytischen Funktionen in neuerer Zeit"; Peano, "Logica Matematica"; Klein, "Zur Frage des höheren mathematischen Unterrichtes." In the much-regretted absence of M. Poincaré, his address was read by M. Franel.

Among the mathematicians present, in addition to those already named, were MM. Brill, Noether, G. Cantor, Dyck, Gordan, Korteweg, Larmor, F. Meyer, Osgood, Vassilief, Veronese, Enriques, Eneström.

THE BRITISH ASSOCIATION.

THE Toronto meeting of the British Association opened on Wednesday in last week, and came to an end yesterday, as we went to press. The reports which have reached us show that the meeting has been a successful one throughout, both from a social and also from a scientific point of view. As in 1884, when the Association met in Montreal, Canadians have shown by the enthusiastic reception given to the members that they value agencies which exist for the diffusion of knowledge and culture. The many papers read before the Sections by no means represent the whole result of such a gathering. The Dominion has been bound closer to the mother country, the interests of science have been brought before the notice of the public, and scientific knowledge will be advanced by the opportunity which the meeting has given for the exchange of ideas. The Montreal meeting of the Association was not only of value in assisting scientific education and research in Canada, but our Transatlantic contemporary—*Science*—acknowledges that it gave a considerable impulse to science

throughout America, the result being that in the thirteen years which have elapsed since the meeting took place, America has come to the front as a nation which fosters scientific work, and a country which contributes a very large share to the world's wealth of natural knowledge.

Twelve hundred members and associates attended the meeting at Toronto, about four hundred being from Great Britain. The proceedings were opened on Wednesday, August 18, by a meeting of the General Committee, when the annual report of the Council for presentation to the Association was read. From the *Times* we learn that the report states that the Council has nominated Sir Donald Smith, Mr. A. S. Hardy, Premier of Ontario, and the Mayor of Toronto as Vice-Presidents of the Association, and regret is expressed at the decision of Mr. Vernon Harcourt to retire from the General Secretaryship of the Association. A warm tribute is paid to him for the invaluable services he has rendered in that capacity during the past fourteen years, and Prof. Roberts-Austen is recommended for appointment as his successor. Mention is made of the fact that the Imperial Government, at the request of the Association, has appointed a committee to report upon the desirability of establishing a National Physical Laboratory. The report states further that the Trustees of the British Museum have under consideration the Association's suggestion for the establishment of a Bureau of Ethnology of Greater Britain in connection with the Museum. The Corporation of Glasgow has forwarded an invitation for the annual meeting of the Association to be held in that city in 1901.

The annual report of the Treasurer shows the finances of the Association to be in a flourishing condition, the balance in hand being 1396*l*. The amount to be granted for various scientific investigations is about 1200*l*.

The sectional work began on Thursday morning, and the presidents of the various sections, with the exception of Anthropology and Botany, delivered their addresses. Two of the sectional addresses were printed in full in last week's NATURE, and also the President's address. We print this week the complete addresses delivered before the sections of Geology, Zoology, and Mechanical Science, and shall follow these with others. We have arranged for our usual reports of the work of the sections, and shall insert them as soon as possible after they are received.

On Friday last there was a special Convocation of Toronto University, under the presidency of the Vice-Chancellor, the Hon. William Mulock, to confer the honorary degree of Doctor of Laws upon Lord Kelvin, Lord Lister, Sir John Evans, and Mr. Hardy (Premier of Ontario). The University has also conferred the same honorary degree upon Lord Rayleigh, Prof. Wolcott Gibbs, and Sir Wilfrid Laurier. At a Convocation of Trinity University on Tuesday, the honorary degree of D.C.L. was conferred upon Lord Kelvin, Lord Lister, Sir John Evans, Mr. Bryce, and Sir George Robertson.

The feature of Friday last was a brilliant discourse delivered by Prof. Roberts-Austen, C.B., F.R.S., on "Canada's Metals." At the close of the lecture, which was illustrated by numerous striking experiments, a vote of thanks was proposed by Dr. George Dawson, and seconded by Sir Charles Fremantle.

A lecture to operatives was given by Dr. Henry O. Forbes on Saturday, upon the subject of "British New Guinea: the Country and its People, with some Account of the Problems which the Region offers to the Naturalist and the Geographer." The Mayor of Toronto, Mr. Shaw, presided, and a large audience attended. On Monday, Prof. John Milne, F.R.S., discoursed upon "Earthquakes and Volcanoes," the President, Sir John Evans, being in the chair.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY G. M. DAWSON, C.M.G., LL.D., F.R.S., F.G.S., PRESIDENT OF THE SECTION.

THE nature and relations of the more ancient rocks of North America are problems particularly Canadian, for these rocks in their typical and most easily read development either constitute or border upon the continental Protaxis of the North. The questions involved are, however, at the same time, perhaps more intimately connected with a certain class of world-wide geological phenomena than any of those relating to later formations, in which a greater degree of differentiation occurred as time advanced. A reasonably satisfactory classification of the crystalline rocks beneath those designated as Palæozoic was first worked out in the Canadian region by Logan and his colleagues, a classification of which the validity was soon after generally recognised. The greatest known connected area of such rocks is embraced within the borders of Canada, and, if I mistake not, the further understanding of the origin and character of these rocks is likely to depend very largely upon work now in progress, or remaining to be accomplished here.

This being the case, it seems very appropriate to direct such remarks as I may be privileged to make on the present occasion chiefly to these more ancient rocks, and the subject is one which cannot fail to present itself in concrete form to the visiting members of this Section. Personally I cannot claim to have engaged in extended or close investigations of these rocks, and there is little absolutely new in what I can say in respect to them; but work of the kind is still actively in progress by members of the staff of the Geological Survey, and the classification and discrimination of these older terranes present themselves to us daily as important subjects of consideration in connection with the mapping of vast areas; so that, if still admittedly imperfect in many respects, our knowledge of them must be appraised, and, at least provisionally, employed in a practical way in order to admit of the progress of the surveys in hand.

Although it is intended to speak chiefly of the distinctively pre-Cambrian rocks of Canada, and more particularly of the crystalline schists, it will be necessary also to allude to others, in regard to the systematic position of which differences of opinion exist. Of the Cambrian itself, as distinguished by organic remains, little need be said, but it is essential to keep in touch with the palæontologically established landmarks on this side, if for no other reason than to enable us to realise in some measure the vast lapse of time, constituting probably one of the most important breaks in geological history, by which the Cambrian and its allied rocks are separated from those of the Huronian and Laurentian systems.

In attempting to review so wide a subject and one upon which so much has already been written, the chief difficulty is to determine how much may be legitimately eliminated while still retaining the important features. This must be largely a matter of individual judgment, and I can only hope to present what appear to me to be the essential points, with special reference to the geology of Canada. The useful object of any such review is, of course, to bring out what may now actually be regarded as established respecting these older rocks, and in what direction the most hopeful outlook exists for improving our knowledge of them. For this purpose, the best mode of approaching the subject, in the first place, and up to a certain point, is the historical one, and it will thus be desirable to recapitulate briefly the first steps made in the classification of the crystalline schists in Canada. This is the more appropriate, because of the substantial accuracy of these first observations, and the fact that they have since been largely buried out of sight by a copious controversial literature of later growth.

Soon after the Geological Survey of Canada was begun, now more than fifty years ago, Logan (who in the earlier years of the work may almost be said to have alone constituted the staff) found himself confronted with the great areas of crystalline rocks forming the continental Protaxis. The existing geological edifice has been so largely the result of the past half-century of work, that it is not now easy to realise the elementary condition in which its foundations lay at that time. It was then but ten years since Sedgwick and Murchison had given form to their discoveries in regard to the Cambrian and Silurian, and a still shorter time since the definite publication of the classification of the Cambrian and the appearance of the "Silurian System,"

while Hall, Emmons and others, working upon these lines, were actively engaged in building up a similar classification of the Palæozoic rocks of the Eastern States of the American Union. The Silurian and Cambrian had, in fact, but just been reclaimed from what Murchison speaks of as the "vast unclassified heaps of greywacke" or "transition limestones."

It would have been quite appropriate at this date to relegate all underlying and more or less completely crystalline rocks to the "Primary," or "Primitive," or "Azoic," but such a solution fortunately did not recommend itself to Logan.

It was along the Ottawa Valley, in 1845, that the rocks subsequently classed under the Laurentian and Huronian systems were first examined in some detail. In that year Logan met with and accurately described, severally, rocks which we now refer to (1) The Fundamental Gneiss; (2) The Grenville Series; and (3) The Huronian. He speaks of the rocks of the first class as being in the main syenitic gneisses "of a highly crystalline quality, belonging to the order which, in the nomenclature of Lyell, is called metamorphic instead of primary, as possessing an aspect inducing a theoretic belief that they may be ancient sedimentary formations in an altered condition." In what we now call the Grenville Series, he describes the association of crystalline limestones and interbedded gneisses, adding that it appeared to be expedient to consider this mass as a separate metamorphic group, supposed to be newer than the last. Of the Huronian, the relations were at that time left undetermined, although it is observed that its beds hold pebbles of the underlying rocks, here the Fundamental Gneiss.

The following season was spent by Logan, and by his assistant Murray, on the north shore of Lake Superior, Thunder Bay and its vicinity being one of the regions especially examined. Without enumerating particular localities, it may be stated that Logan there grouped the rocks met with as follows, beginning with the lowest; the column added on the left giving the present nomenclature of the several series defined:—

Laurentian	1. Granite and syenite. 2. Gneiss.
Huronian	3. Chloritic and partly talcose and conglomerate slates [schists].
Animikie	4. Bluish slates or shales interstratified with trap.
Keweenawan ...	5. Sandstones, limestones, indurated marls and conglomerates, interstratified with trap.

It is not distinctly stated that No. 3 rests unconformably on the older rocks, but the observation that granitic boulders were found in it, leads to the belief that such unconformity was assumed. Murray, however, supposed the junction as seen on the Kaministiquia to be conformable, and unites the first three subdivisions, as above given, in one series.

Logan further states, still referring to the same region, that the "chloritic slates [schists] at the summit of the older rocks on which the volcanic formations rest unconformably, bear a strong resemblance to those met with on the upper part of Lake Temiscaming on the Ottawa, and it appears probable that they will be found to be identical."

It will thus be observed that the progress in classification made, up to this date at least, entirely accords with the results of the latest investigations. The identity of the rocks placed third in the table with those of the Upper Ottawa was more than conjectured, and the existence of a great stratigraphical break at the base of what is now known as the Animikie was clearly recognised. The several formations were merely described. No specific names were given to them at this time by Logan, and it is further stated that the age of the highest formations (Animikie and Keweenawan) was in doubt, although some reason was found to support Houghton's (then State Geologist of Michigan) view (or what was believed to be his view), that these formations are lower than the Potsdam, or "lowest fossiliferous formation."

In 1847 and 1848, investigations were continued along the north shore of Lake Huron, of which the characteristic rocks are, it is stated, believed to form a single system. They are described as in part sedimentary (quartzites, conglomerates, &c.), and in part igneous (greenstones), the latter being both interposed between the sedimentary beds and intrusive. The "slates" are particularly characterised by Murray as often chloritic, epidotic, and micaceous, and would now, of course, be more specifically termed schists.

Writing in 1849 ("Report on the North Shore of Lake Huron"), however, and later, in a communication presented to this Association in 1851, Logan, although still recognising the manifest unconformity at the base of the Animikie, speaks collectively of the "Copper-bearing Rocks" of Lake Superior and Huron, including under this general term what are now known as the Huronian, Animikie, and Keweenawan series, and adds that it is "highly probable" that all these are approximately equivalent to each other, and to the Cambrian of the British Islands.

In the Report for 1852-53 (published 1854), the name Laurentian was adopted for what had been previously designated merely as the "metamorphic series," and in the geological sketch printed in Paris in connection with the Exhibition of 1855 (which follows next in order of publication), this system is stated to consist almost exclusively of much altered and disturbed sedimentary beds. It is also, however, made to include some recognised intrusives, such as granite and syenites, forming parts of the mass, as well as the Labradorite rocks, which were afterwards for a time named Upper Laurentian, and to which further allusion will be made in the sequel. The name Laurentian is here, therefore, first employed exactly in the sense of the term "Basement Complex," introduced long afterwards, but under the distinct idea that most of the rocks are altered sediments, from which certain intrusive masses were not clearly separable.

In the same publication, the overlying series of Lakes Huron and Superior, including the Huronian proper, the Animikie and the Keweenawan, were collectively spoken of as the "Huronian or Cambrian system." These rocks are described as lying discordantly on the Laurentian, and as intervening between it and the lowest known fossiliferous strata. There being no other recognised place for such rocks in the scheme of the day, they are consequently supposed to represent the Lower Cambrian of Sedgwick.

It is unnecessary to follow in order the investigations carried on for a number of subsequent years, but reference may now be made to the "Geology of Canada," of 1863, in which all previous results of the Survey to that date were collected and systematised. In this volume, after stating that Hall's nomenclature of the Palæozoic rocks in the State of New York had been adopted unchanged for the adjacent Canadian territory, "in the interests of unity of plan for future researches," Logan writes:—"To the Azoic rocks no local names have yet been applied in any part of America except in Canada," and adds:—"The names of the Laurentian and Huronian systems or series, which we have been accustomed to apply to them, are allowed to remain unchanged, particularly as they have been recognised abroad, and have been made by other geologists a standard of comparison both in America and Europe."

In Chapter V. of this volume the "Upper Copper-bearing Rocks of Lake Superior" are separately treated, and are recognised as comprising two groups which are stated to overlie the Huronian unconformably. These groups are those now known as the Animikie and Keweenawan.

There can be no doubt about the classification intended at this time, and the rocks are correctly laid down on the atlas prepared to accompany the volume, but in consequence of an unfortunate error in the geographical description of the distribution of the Huronian about Thunder Bay, that arose in 1846 and was repeated in 1863, several later investigators have been led to regard the rocks of the "Upper Copper-bearing Series" as those of Logan's typical Huronian, and to suppose that when examining these rocks they were dealing with those intended to be classed as Huronian. Irving, Winchell and others have adopted this mistaken view, which it is particularly necessary to refer to here, as it has been the chief cause of all subsequent misapprehension in regard to the "Original Huronian."[1]

1 As already stated, the relations of the principal rock-series of the vicinity of Thunder Bay had been correctly outlined in 1846, although the series had not at that time been named. The Kaministiquia River section had been examined by Murray, who also correctly described the distribution of the series there, stating that the "granite, syenite, gneiss, micaceous and chloritic schist" (Laurentian and Huronian) find their southern limit on a line running from the falls on that river to the "head of Thunder Bay," while the "Upper Slates (Animikie) rest upon them and occupy the country between such a line and Lake Superior" ("Report of Progress," 1846-47, p. 51). In combining his own results with those of Murray, Logan describes the southern line of the granite, gneiss, and chloritic slates as "commencing in the vicinity of Fort William," or at the *mouth* of the Kaministiquia, although the falls, at which this line had been determined by Murray, are some twenty miles up the river. Proceeding (*op. cit.* p. 25) to describe the extent of the "superior trappean formations" (Animikie and Keweenawan), he then reverts to the line previously stated, making these rocks to terminate locally where

The temporary grouping of the Huronian proper with the "Upper Copper-bearing Series" (Animikie and Keweenawan), on the grounds already explained, as "Huronian or Cambrian," together with the employment (proper enough at the date) of the term "slates" for rocks that would now be named schists, further assisted in giving colour to the erroneous view just referred to.

In a second geological sketch of Canada, printed in Paris at the time of the International Exhibition of 1867, the same classification is maintained, but to it is added the Upper Laurentian or Labradorian. This sketch was actually written by Hunt, but it was an official publication correctly representing the views held at that time, and may be accepted as Logan's last word on the subject. As thus defined and established, he left the Laurentian and Huronian systems.

In so far as the stratigraphical relations of the Laurentian, Huronian, and "Upper Copper-bearing Series" are concerned (leaving out of consideration the Labradorian), it is thus manifest that the conclusions originally formed from actual study on the ground were those finally held by Logan. The reference for a time of the Huronian proper and the "Upper Copper-bearing Series" together to the Lower Cambrian, meant only that, as then understood, there was no other systematic position recognised to which they could be assigned. That a great unconformity existed between these two systems was never doubted, but for some years Logan was not prepared to take the bold position of constituting a separate Huronian system beneath the lowest Cambrian; he was, on the contrary, anxious, if possible, to bring the Canadian section within the lines established in the classic region studied by Sedgwick and Murchison. The introduction of new systematic terms was at that time considered somewhat seriously. When eventually compelled to take this step (in 1857), he confined the name Huronian to rocks antedating the great break at the base of the "Upper Copper-bearing Series" (Animikie), embracing those first seen by him on the Upper Ottawa and on Lake Huron, with their representatives elsewhere, under this new system.

In so far as nomenclature goes, Logan thus certainly modified his original application of the name Huronian; it was not, however, as has been contended, to create an "extended Huronian," but on the contrary to restrict the name to rocks beneath the great unconformity at the base of the Animikie. The change was necessitated by the progress of investigation and by the recognition of an upper division of the "Azoic," beneath anything that could legitimately be classed as Cambrian. It was made by the author himself, and involved no departure from the law of priority or from any other acknowledged rule. In finally eliminating these upper rocks from his Huronian system, he was no doubt influenced by Whitney's criticisms of 1857 (*Am. Journ. Sci.*, vol. xxiii., May 1857), which were in part correct, although largely devoted to the very conservative contention that all stratified rocks below the great break were inseparable, and should be included in an "Azoic System." This influence may be traced in an important paper, of but three pages, communicated to the American Association for the Advancement of Science a few months later than the date of that above referred to, in which, while the name Huronian is reaffirmed for the rocks of Lake Huron and Lake Temiscaming, which are taken as typical of the system, nothing further is said of those now known as Animikie and Keweenawan.

In the summary volume of 1863, to which allusion has already been made, the existence of an Upper Laurentian, Labradorian or Norian Series was first tentatively indicated in a supplementary chapter. It is unnecessary to follow here the history of the rocks so classed, for the supposed series has not stood the test of later discussion and research, due chiefly to Selwyn and Adams. The apparently stratified rocks often included in it are now understood to be foliated eruptives. The recognition achieved by this and by other more or less hypothetical series about this time may be traced to the brilliant chemico-geological theories advanced by Hunt, previous to the general acceptance of modern petrographical methods.

In a similar manner, and very justly so, Logan, as a field geologist, was influenced by the views held by Lyell in the early editions of his "Principles," to accept without reservation the foliation of crystalline rocks as indicative of original bedding. This was, at the time of his early researches and thereafter for many years, the accepted view, although Dana, in a paper read before the American Association for the Advancement of Science in 1843, had already held that the schistose structure of gneiss and mica-slate was insufficient evidence of sedimentary origin; and Darwin, a few years later, had published his "Geological Observations," including a remarkable chapter on cleavage and foliation, in which he advocated a similar view. No such doctrine, however, achieved general recognition until long afterwards, while that class of facts remaining to be determined chiefly by the microscope, which may be included under the term "dynamic metamorphism," were wholly unknown and unforeseen.

In admitting that chemical, metamorphic, and uniformitarian hypotheses were thus given, in turn, undue weight, it is not to be assumed that the advances made under these hypotheses have been entirely lost; it has been necessary only to retreat in part in each instance, in order to fall again into the more direct road.

In late years, modern microscopical and chemical methods of research have been applied to the ancient crystalline schists of Canada—the older work has been brought under review, and new districts have been entered upon with improved weapons. Here, as in other parts of the world, investigations of the kind are still in active progress; finality has not been reached on many points, but the explanation of others has been found. One advance which deserves special mention is the recognition of the fact that a great part of the Huronian is essentially composed of contemporaneous volcanic material, effusive or fragmental. This was first clearly stated by Canadian geologists, but has only become generally admitted by degrees, in opposition to prevalent theories of metamorphism and cosmic chemistry.

The first opportunity of studying these Archæan rocks in detail, under the new conditions, fell to Dr. A. C. Lawson, then on the Staff of the Canadian Survey, in the vicinity of the Lake of the Woods and elsewhere to the west of Lake Superior. In that part of the Protaxis, the Laurentian appears to be represented only by the Fundamental Gneiss, and the Huronian, by a series to which a local name (Keewatin) was appropriately given,[1] but which is now known to differ in no essential respect from many other developments of the same system. The Huronian stands generally in compressed folds, and along the line of junction the gneisses are related to it in the manner of an eruptive, penetrating its mass and containing detached fragments from it. The same or very similar relations have since been found to occur in many other places.

Arguing from observations of the kind last mentioned, it was too hastily assumed by some geologists that the Laurentian as a whole is essentially igneous, and later in date than the Huronian. The conditions are, however, not such as to admit of an unqualified belief of this kind, even in regard to the Fundamental Gneiss. We may go so far as to assume that these rocks (occupying as they do much the larger part of the entire Protaxis) constitute a great "batholitic" mass of material at one time wholly fluent; but even on this hypothesis some primitive floor must have existed upon which the Huronian and the similarly circumstanced Grenville Series were laid down, and no such enormous substitution can have obtained as to result in the replacement of the whole of this floor by exotic material.[2] It seems much more probable that but limited tracts of the Fundamental Gneiss have passed into a fluent condition when at great depths in the earth's crust, and various arguments may be adduced in favour of a belief that the observed lines of contact might be those along which such fusion would be most likely to occur.[3] Moreover, the Huronian in many and widely separated localities is found to contain water-rounded fragments of syenitic,

he had said the older rocks began. In recasting the earlier observations for the volume of 1863 (no further work having meanwhile been done at this place), Logan is thus naturally led to state that the Huronian (*i.e.* the "Chloritic Slates") *occupies the coast east of the Kaministiquia*, whereas this coast, for ten or eleven miles, is actually occupied by Animikie rocks. Subsequent investigators, inspecting this coast-line with the volume of 1863 as a guide, very naturally thus assumed that they were examining Logan's "typical Huronian," or a part of it. It is in consequence only of a too consistent adhesion to this misunderstanding, that it has been found necessary to speak of an "Upper Huronian," and refer to an "inter-Huronian" unconformity. The so-called Upper Huronian is no part of the system as understood by the Canadian Survey. One cannot fail to note, in reading much that has been written on this subject, that the importance of the great unconformity at the base of the Animikie was realised only after a new classification had been adopted, in which it had practically been ignored.

1 In the Archæan, local names are particularly useful, inasmuch as correlation must proceed on lithological and stratigraphical data, more or less uncertain when extended to wide areas, even in the case of the older and more homogeneous strata of the earth's crust.

2 For analogous phenomena of much later date geologically, see Annual Report Geological Survey of Canada, 1886, p. 11 B.

3 Hypotheses on this subject are well summarised by Van Hise. Annual Report U.S. Geol. Survey, 1894–95, p. 749

granitic and gneissic rocks, forming conglomerates, which may often be observed to pass into schists, but still plainly indicate that, in these places at least, materials not unlike those of the Fundamental Gneiss and its associates were at the surface and subject to denudation. Such materials cannot be regarded as parts of any primeval superficial crust of the earth in an original condition. They represent crystalline rocks formed at great depths, and under conditious similar, at least, to those under which the Fundamental Gneiss was produced. They imply a great pre-Huronian denudation, and show that the Huronian must have been deposited unconformably either upon the Fundamental Gneiss itself, or upon rocks occupying its position and very similar to it in character. There can be no reasonable doubt that the mass of what now constitutes the Fundamental Gneiss originally existed as the floor upon which the Huronian was deposited.

The name Archæan has been adopted and employed by the Geological Survey of Canada in the sense in which it was introduced (in 1874), and consistently maintained by Dana—*i.e.* to include all rocks below the great hiatus of which evidence was first found in the Lake Superior region. The author of the name never assented to its restricted application as proposed by Irving and followed by Van Hise and others, and as a synonym for the Fundamental Gneiss or "Basement Complex" it is not only unnecessary but is scarcely etymologically correct, if we admit that a part of the "Complex" is of comparatively late date.

We have reached a point at which we may ask what is now our conception of these Archæan rocks in Canada, and more particularly in the great Protaxis, as resulting from the most recent investigations of a critical kind. The reply may be given briefly from the latest reports of those still at work on the problems involved as follows:—

The *Laurentian* comprises (1) the Fundamental Gneiss or Lower Laurentian (also referred to as the Ottawa Gneiss or Trembling Mountain Gneiss in older Reports), and (2) the Grenville Series. An important part of the gneisses of the Grenville Series has been shown by chemical analysis to be identical in composition with ordinary Palæozoic argillites, and they are interbedded with quartzites and massive limestones, also evidently of aqueous origin, and in some places abounding in graphite. These beds are, however, closely associated with other gneisses in which orthoclase largely preponderates that have the composition of igneous rocks. The Fundamental Gneiss consists chiefly, if not exclusively, of rocks of the last-named class, the banding of foliation of which, though now generally parallel to that of the Grenville Series, has probably been produced mainly or entirely by movements induced by pressure, in a mass originally differing more or less in composition in its different parts. These two series are sometimes separable on the ground locally, but with difficulty: in other places they cannot be clearly defined (*cf.* Adams, Annual Report Geological Survey of Canada, 1895).

The Upper Laurentian, Labradorian, Norian or Anorthosite group, maintained for a number of years on the evidence already mentioned, is found to consist essentially of intrusive rocks, often foliated by pressure, later in age than the Grenville Series, but in all probability pre-Palæozoic.

The *Huronian* comprises felspathic sandstone or greywacke more or less tufaceous in origin, quartzites and arkoses passing into quartzose conglomerates and breccia conglomerates, often with large fragments of many different varieties of granite, syenite, &c., diorite, diabase, limestones, and shales or slates changing to phyllites in contact with the numerous associated igneous masses. Over wide areas altered greenstones and their associated tuffs preponderate, often with micaceous, chloritic, sericitic and other schists, many of which are of pyroclastic origin, although some may represent ordinary aqueous deposits, and all have been much affected by subsequent dynamic metamorphism.

The Huronian rocks have not yet been found in distinct relation to those of the Grenville Series, but are generally in contact with the Fundamental Gneiss, in the manner previously alluded to. Where not composed of volcanic material it appears to be largely of a littoral character, while the Grenville Series seems rather to indicate oceanic conditions.

No reference has so far been made to the development of Archæan rocks, known as the "Hastings series." The rocks thus named occupy considerable tracts to the south of the Ottawa River, west of the City of Ottawa. They were originally classed by Logan and Murray with the Grenville Series of the Laurentian, although Murray soon after insisted on their peculiar features, and they came to be recognised by the above geographical name during subsequent discussions as to their systematic position, by the authors above referred to, and by Hunt, Vennor, and Macfarlane. These rocks are particularly alluded to now, because later work seems to show that both the Grenville Series and the Huronian are represented in the district —in so far, at least, as lithological characters may be depended on. They include a preponderance of thinly-bedded limestones and dolomites, finer in grain and usually less altered than those of the typical Grenville Series, associated with conglomerates, breccias and slates still retaining complete evidence of their clastic origin.

It is in this Hastings region that careful investigation and mapping are now in progress by several members of the Canadian Survey, with the prospect of arriving at definite results respecting the relations of the Grenville Series and the Huronian. It is too early to forecast what these results may be, for the question is one which must be approached with an open mind; but the work already completed by Messrs. Adams, Barlow, and Ells, appears to sustain the suggestion that both series occur, and to indicate that they may there be so intimately connected as to render their separation difficult. It must be borne in mind that, although the relations of the Grenville Series and those of the recognised Huronian to the Fundamental Gneiss are very similar, they characterise distinct tracts, to which the Hastings district is to some extent geographically intermediate, although most closely connected in this respect with the Grenville region.

Reverting to the original classification of the Archæan of the Canadian Survey, as developed in the field by Logan and his assistants, we may now inquire—In how far does this agree with the results of later work above outlined? In the main, this classification still stands substantially unaltered, as the result of all honest work carefully and skilfully executed must. The nomenclature adopted is still applicable, although some of our conceptions in regard to the rocks included under it have necessarily undergone more or less change.

The Laurentian is still appropriately made to include both the Fundamental Gneiss and the Grenville Series; although at first both were supposed to represent "metamorphic" rocks, it was even then admitted (1855) that these embraced some plutonic masses practically inseparable from them. Later investigations have increased the importance of such plutonic constituents, while at the same time demonstrating the originally supposed sedimentary origin of the characteristic elements of the Grenville Series; but the admission of so large a plutonic factor necessarily invalidates in great measure the estimates of thickness based upon the older reasoning, under which any parallelism of structure was accepted as evidence of original bedding.

Whatever views may be held as to the propriety of including rocks of the two classes under a single name, the necessity of so doing remains, because of the practical impossibility of separating them over any considerable area for the purpose of delineation on the map. No advance in knowledge is marked in substituting for Laurentian, with its original concept of a stratified time-series, such a name as "Basement Complex." It may, indeed, yet prove that the homogeneity of the Laurentian is greater than is at present supposed, for a mass of strata that included ordinary sediments, arkoses, and contemporaneous volcanic deposits of certain kinds, in which the arkose and volcanic constituents preponderated in the lower beds, might, under metamorphism at great depths, produce just such a combination as that of the Grenville Series and the Fundamental Gneiss, the latter representing an aggregate result of the alteration of that part composed chiefly of volcanic material or of arkose—in fact, under the conditions assumed, the lower mass could not now well exist under any other form than that actually found in the Fundamental Gneiss. In his address at the Nottingham Meeting of this Association, Teall has clearly pointed out that, in such cases, the chemical test must necessarily fail, and that the character and association of the rocks themselves must be given a greater weight.

The Huronian proper, under whatever local names it may be classed, still remains a readily separable series of rocks, with peculiar characters, and economically important because of the occurrence in it of valuable minerals.

The subsequently outlined Labradorian has been eliminated as a member of the time-series, and the rocks of the so-called "Hastings Group" remain yet in a doubtful position, but with the promise that they may afford a clue to the true relations of

the Grenville Series of the eastern and the Huronian of the western province of the Protaxis.

To what extent the above subdivisions of the Archæan may be legitimately employed in other parts of the continent, more or less remote from the Protaxis, remains largely a question for future investigation. In the southern part of New Brunswick, however, the resemblance of the Archæan to that of the typical region is so close that there can be little risk of error in applying the same classificatory names to it. The Fundamental Gneiss is there in contact with a series comprising crystalline limestones, quartzites, and gneissic rocks, precisely resembling those of the Grenville Series. Later than this is a great mass of more or less highly altered rocks, chiefly of volcanic origin, comprising felsites, diorites, agglomerates, and schists of various kinds, like those of the typical Huronian. The existence of this upper group correlatively with that representing the Grenville Series, constitutes an argument, so far as it goes, for the separateness of these two formations in the general time-scale. All these Archæan rocks of New Brunswick are distinctly unconformable beneath fossiliferous beds regarded by Matthew as older than Cambrian.

In the Cordilleran region of Canada, again, a terrane is found lying unconformably beneath the lowest rocks possibly referable to the Cambrian, evidently Archæan, and with a very close general resemblance to the Grenville Series. To this the local name Shuswap Series has been applied, and a thickness of at least 5000 feet has been determined for it in one locality. It consists of coarsely crystalline marbles, sometimes spangled with graphite and mica, quartzites, gneisses, often highly calcareous or quartzose, mica schists, and hornblendic gneisses. With these is a much greater mass of gneissic and granitoid rocks, like those of the Fundamental Gneiss of the Protaxis, and the resemblance extends to the manner of association of the two terranes, of which, however, the petrographical details remain to be worked out (*cf.* Annual Report Geological Survey of Canada, 1888-89, p. 29 B.).

While it is true that a resemblance in lithological character, like that existing between the Grenville and Shuswap Series, far remote from each other geographically, may mean only that rocks of like composition have been subjected to a similar metamorphism, both the series referred to are separated above by an unconformity from the lowest beds of the Palæozoic, and there is thus sufficient evidence to indicate at least a probability of their proximate identity in the time-scale. In Scotland, an analogous series, and one apparently similarly circumstanced, seems to occur in the rocks of Gairloch and Loch Carron (*cf.* Geikie, "Ancient Volcanoes of Great Britain," vol. i. p. 115).

Particular attention has been directed throughout to the southern part of the continental Protaxis in Canada. In this region it happened that the Archæan rocks and those resting upon them were originally studied under exceptionally favourable conditions, for ever since the great revolution which succeeded Huronian time, the region is one which has remained almost stable. Selwyn and N. H. Winchell have particularly insisted on the importance of the stratigraphical break which here defines the Archæan above. It is not everywhere so well marked, for in the Appalachian province and in the country to the south of the great lakes, in Wisconsin and Michigan, repeated subsequent earth-movements have flexed and broken the older strata against the base of the table-land of the Protaxis. It is not from these districts, subjected to more recent and frequent disturbance, that the ruling facts of an earlier time may be most easily ascertained. Much careful and conscientious work has been devoted to them, but it is largely, I believe, because of the attempt to apply, for purposes of general classification, the still unsettled and ever-changing hypotheses derived from such more complicated tracts that so much confusion has been introduced in regard to the Archæan and early Palæozoic rocks.

If the unconformity closing Archæan time in the vicinity of the Great Lakes had been observed only in that region, it might be regarded as a relatively local phenomenon; but subsequent observations, and more particularly those of the last few years, due to Bell, McConnell, Tyrrell, and Low, show that rocks evidently representing the Animikie and Keweenawan, and practically identical with those of Lake Superior in general lithological character, recur in many places almost throughout the whole vast area of the Protaxis, on both sides of Hudson Bay, and northward to the Arctic Ocean, resting upon the Archæan rocks always in complete discordance, and lying generally at low angles of inclination, although often affected by great faults. The surface upon which these rocks have been deposited is that of a denudation-plane of flowing outline, not differing in any essential respect from that characterising parts of the same great plateau where there is no evidence to show that any deposition of strata has occurred since Archæan time. Mr. Low, indeed, finds reason to believe that even the great valleys by which the Archæan plateau of Labrador is trenched had been cut out before the general subsidence which enabled the laying down of Animikie rocks upon this plateau to begin. The area over which these observations extend, thus in itself enables us to affirm that the unconformity existing between the Animikie or Keweenawan (as the case may be) and the Archæan is of the first order (*cf.* Selwyn, *Science*, February 9, 1883). It may be compared with that now known to occur between the Torridonian of Scotland and the underlying rocks there, and is evidenced by similar facts.

If the structural aspects of the Archæan rocks of the Protaxis are considered, the importance of this gap becomes still more apparent. We find long bands of strata referable to the Huronian and Grenville Series, occupying synclinal troughs, more or less parallel to each other and to the foliation of the Fundamental Gneiss, the strata, as well as the foliation, being in most cases at high angles, vertical, or even reversed. This structure is precisely that which would be discovered if a great mountain system, like that of the Alps, were to be truncated on a plane sufficiently low. Analogy thus leads to the belief that the Protaxis was originally, as Dana has suggested, a region of Appalachian folding, differing only from more modern examples of mountain regions of the same kind in its excessive width, which is so great as to render it difficult to conceive that crustal movements of sufficient magnitude to produce it could have occurred at any one period. It is thus, perhaps, more probable that successive and nearly parallel flexures of the kind, separated by long intervals of rest, piled range upon range against the central mass of the protaxial buttress subsequent to the Huronian period. In any case, the rugged mountain region brought into existence when the corrugation still evidenced by its remaining base occurred, was subsequently reduced by denudation to the condition of an undulating table-land such as has been named a "peneplain" by W. M. Davis—a surface approximating to a base-level of erosion. All this was accomplished after the close of the Huronian period, and before that time at which the first beds of the Animikie were laid down correlatively with a great subsidence. It would be difficult to deny that the time thus occupied may not have been equal in duration to that represented by the whole of the Palæozoic.

If we approach this ruling unconformity from above, in the region of the Protaxis, we find the Animikie and Keweenawan rocks uncrystalline, except when of volcanic origin, and resembling in their aspect the older Palæozoic sediments, but practically without characteristic organic remains so far as known. In order to bring ourselves into relation with the ascertained palæontological sequence, it is necessary to go further afield, and in so doing we lose touch, more or less completely, with the stable conditions of the Archæan platform, and are forced to apply indirectly such facts as it may be possible to ascertain in regions which have suffered more recent and complicated disturbance. It is thus not surprising that the taxonomic position of the Animikie and Keweenawan have been the subject of much controversy. It is not germane to the present discussion to enter at any length into this question, nor into the value of the unconformity which appears to exist between these two series. They have been classed collectively by Selwyn, N. H. Winchell, and others as Lower Cambrian, and are provisionally mapped as such by the Canadian Survey. It is believed to be more in accordance with the general principles of geological induction to refer these rocks above the great unconformity to the Cambrian, for the time being at least, than to unite them with the Huronian under any general term, or to erect a new system in which to place them. In so doing it has been assumed that the Cambrian is the lowest system of the Palæozoic, but of late years the position has been taken by good authorities that the true base of the Cambrian is to be found at the *Olenellus* zone; and while it appears very probable that, when fossils are found in the Animikie, they may be referable to this zone, the adoption of such an apparently

arbitrary line certainly, for the time, must be considered as placing the Cambrian reference of the beds in question in doubt; but it does not interfere with a belief that if they should be found to be lower than Cambrian as thus defined, they may at least be considered as still in all probability Palæozoic.

The definition of the horizon of *Olenellus* as that of the base of the Cambrian is a question almost entirely palæontological, into which it is not proposed here to enter, further than to point out that it is only partially justified by what is known of North American geology. In the Atlantic province, and in the Appalachian region, there appears to be a very general physical break at about this stage, which it seems likely may correspond with the great unconformity at the base of the Animikie; but in the Rocky Mountain or Cordilleran region the *Olenellus* zone has been found high up in a series of conformable and similar sediments, coinciding with no break, and from these lower sediments some organic forms have been already recovered, but not such as to indicate any great diversity in fauna from that of the recognised Cambrian. Similarly, in one part of eastern Canada, Matthew has lately desciibed a fauna contained in what he names the Etcheminian group, regarded by him as earlier than the *Olenellus* zone, but still Palæozoic. Recent discoveries of a like kind have been made in other parts of the world, as in the Salt Range of India. These facts have only last year been particularly referred to by Mr. Marr in his address to the Section.

The general tendency of our advance in knowledge appears, in fact, to be in the direction of extending the range of the Palæozoic downward, whether under the old name Cambrian, or under some other name applied to a new system defined, or likely to be defined, by a characteristic fauna; and under Cambrian or such new system, if it be admitted, it is altogether probable that the Animikie and Keweenawan rocks must eventually be included.

In other words, the somewhat arbitrary and artificial definition of the *Olenellus* zone as the base of the Cambrian, seems to be not only not of world-wide application, but not even of general applicability to North America; while, as a base for the Palæozoic Æon, it is of still more doubtful value. In the Cambrian period, as well as in much later geological times, the American continent does not admit of treatment as a single province, but is to be regarded rather as a continental barrier between two great oceanic depressions, each more or less completely different and self-contained in conditions and history—that of the Atlantic and that of the Pacific. On the Atlantic side the *Olenellus* zone is a fairly well-marked base for the Cambrian; on that of the Pacific it is found naturally to succeed a great consecutive and conformable series of sediments, of which the more ancient fauna is now only beginning to be known.

In thus rapidly tracing out what appears to me to be the leading thread of the history of the pre-Cambrian rocks of Canada, and in endeavouring to indicate the present condition of their classification, and to vindicate the substantial accuracy of the successive steps taken in its elaboration, many names and alternative systems of arrangement proposed at different times, by more or less competent authorities, have been passed without mention. This has been done either because such names and classifications appear now to be unnecessary or unfounded, or because they relate to more or less local subdivisions of the ruling systems which it is not possible to consider in so brief a review. This has been particularly the case in regard to the much-disputed region to the south of Lake Superior, out of which, however, after some decades of complicated and warring nomenclature, a classification, trending back substantially to that originally established and here advocated, is being evolved (albeit under strange names) by the close and skilful stratigraphical work in progress there.

It has also been my object, in so far as possible, by omitting special reference to divergent views, to avoid a controversial attitude, particularly in respect to matters which are still in the arena of active discussion, and in regard to which many points remain admittedly subject to modification or change of statement. But in conclusion, and from the point of view of Canadian geology, it is necessary to refer—even at the risk of appearing controversial—to the comparatively recent attempt to introduce an "Algonkian System," under which it is proposed to include all recognisable sedimentary formations below the *Olenellus* zone, assumed for this purpose to be the base of the Cambrian. If in what has already been said I have been able correctly to represent the main facts of the case—and it has been my endeavour to do so—it must be obvious that the adoption of such a "system" is a retrograde step, wholly opposed, not only to the historical basis of progress in classification, but also to the natural conditions upon which any taxonomic scheme should be based. It not only detaches from the Palæozoic great masses of conformable and fossiliferous strata beneath an arbitrary plane, but it unites these, under a common systematic name, with other vast series of rocks, now generally in a crystalline condition, and includes, as a mere interlude, what, in the region of the Protaxis at least, is one of the greatest gaps known to geological history. In this region it is made to contain the Keweenawan, the Animikie, the Huronian, and the Grenville Series, and that without in the least degree removing the difficulty found in defining the base of the last-mentioned series. It thus practically expunges the result of much good work, conducted along legitimate lines of advance during many previous years, with only the more than doubtful advantage of enabling the grouping together of many widely separated terranes in other districts where the relations have not been even proximately ascertained. It is in effect, to my mind, to constitute for geology what was known to the scholastic theologians of a former age as a *limbo*, appropriate as the abode of unjudged souls and unbaptised infants, that might well in this case be characterised as "a limbo large and broad."

It is not intended to deny that there may be ample room for the introduction of a new system, or perhaps, indeed, of an entire Geological Æon, between the Huronian, as we know it in Canada, and the lowest beds which may reasonably be considered as attaching to the Cambrian, or even to the Palæozoic as a whole. On the contrary, what has already been said will, I think, show that in the region of the Protaxis we might very reasonably speak of an "Algonkian hiatus," if we elect so to call it. Elsewhere it will undoubtedly be possible, sooner or later, to designate series of rocks laid down during the time represented only by orogenic movements and vast denudation in the province here more particularly referred to; but before any general systematic name is applied to such terranes they should be defined, and that in such a way as to exclude systems already established as the result of honest work.

It seems very likely, for instance, that the Grand Cañon Series, as last delimited by Walcott, separated by unconformities from the Tonto Cambrian above and the probably Archæan rocks below, may be referable to such an intermediate system; but here it may be noted, in passing, that the attempt to apply the new term "Algonkian" in this particular Western region, has led to the inclusion under that name of a great unconformity below the Grand Cañon Series, much resembling the post-Huronian break in the Lake Superior district.

For such unclassed rocks, wholly or in large part of sedimentary origin, the Canadian Survey has simply employed the term pre-Cambrian, involving for certain regions a frank confession of ignorance beyond a certain point. Indefinite as such a term is, it is believed to be more philosophical than to make an appearance of knowledge not borne out in fact, by the application of any systematic name not properly defined.

Although it would be unsuitable, at the close of this address, to introduce the old controversy respecting the Cambrian and Silurian, it may be noted that the ethical conceptions and many of the principles involved in that discussion still apply with undiminished value, and much of its literature may be re-read today with advantage. More particularly I would allude to Sedgwick's inimitable and now classic introduction to McCoy's "Palæozoic Fossils," one passage in which, paraphrased only by the change of names involved in that and in the present discussion, may be read as follows:—"'*Est Jupiter quodcunque vides*' was once said by Dean Conybeare in mockery of the old despotic rule of the name Greywacké. A golden age of truth and reason, and slow but secure inductive logic, seemed to follow, but the jovial days of a new dynasty are to spring up, it seems, under a new name not less despotic than the one which had ruled before it. If all the [sedimentary] rocks below the [*Olenellus* zone] are to pass under one name, let us cling to the venerable name Greywacké. It can do no mischief while it describes things indefinite, simply because it is without meaning. But the name [Algonkian], if used in the same extended sense, is pregnant with mischief. It savours of a history that is fabulous; it leads us back to a false type; it unites together as one systems that nature has put asunder."

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY PROF. L. C. MIALL, F.R.S., PRESIDENT OF THE SECTION.

It has long been my conviction that we study animals too much as dead things. We name them, arrange them according to our notions of their likeness or unlikeness, and record their distribution. Then perhaps we are satisfied, forgetting that we could do as much with minerals or remarkable boulders. Of late years we have attempted something more; we now teach every student of Zoology to dissect animals and to attend to their development. This is, I believe, a solid and lasting improvement; we owe it largely to Huxley, though it is but a revival of the method of Döllinger, who may be judged by the eminence of his pupils and by the direct testimony of Baer to have been one of the very greatest of biological teachers. But the animals set before the young zoologist are all dead; it is much if they are not pickled as well. When he studies their development, he works chiefly or altogether upon continuous sections, embryos mounted in balsam, and wax models. He is rarely encouraged to observe live tadpoles or third-day chicks with beating hearts. As for what Gilbert White calls the *life and conversation of animals*, how they defend themselves, feed, and make love, this is commonly passed over as a matter of curious but not very important information; it is not reputed scientific, or at least not eminently scientific.

Why do we study animals at all? Some of us merely want to gain practical skill before attempting to master the structure of the human body; others hope to qualify themselves to answer the questions of geologists and farmers; a very few wish to satisfy their natural curiosity about the creatures which they find in the wood, the field, or the sea. But surely our chief reason for studying animals ought to be that we would know more of life, of the modes of growth of individuals and races, of the causes of decay and extinction, of the adaptation of living organisms to their surroundings. Some of us even aspire to know in outline the course of life upon the earth, and to learn, or, failing that, to conjecture, how life originated. Our own life is the thing of all others which interests us most deeply, but everything interests us which throws even a faint and reflected light upon human life. Perhaps the professor of Zoology is prudent in keeping so close as he does to the facts of structure, and in shunning the very attempt to interpret, but while he wins safety he loses his hold upon our attention. Morphology is very well; it may be exact; it may prevent or expose serious errors. But Morphology is not an end in itself. Like the systems of Zoology, or the records of distribution, it draws whatever interest it possesses from that life which creates organs and adaptations. To know more of life is an aim as nearly ultimate and self-explanatory as any purpose that man can entertain.

Can the study of life be made truly scientific? Is it not too vast, too inaccessible to human faculties? If we venture into this alluring field of inquiry, shall we gain results of permanent value, or shall we bring back nothing better than unverified speculations and curious but unrelated facts?

The scientific career of Charles Darwin is, I think, a sufficient answer to such doubts. I do not lay it down as an article of the scientific faith that Darwin's theories are to be taken as true; we shall refute any or all of them as soon as we know how; but it is a great thing that he raised so many questions which were well worth raising. He set all scientific minds fermenting, and not only Zoology and Botany, but Palæontology, History, and even Philology bear some mark of his activity. Whether his main conclusions are in the end received, modified, or rejected, the effect of his work cannot be undone. Darwin was a bit of a sportsman and a good deal of a geologist; he was a fair anatomist and a working systematist; he keenly appreciated the value of exact knowledge of distribution. I hardly know of any aspect of natural history, except synonymy, of which he spoke with contempt. But he chiefly studied animals and plants as living beings. They were to him not so much objects to be stuck through with pins, or pickled, or dried, or labelled, as things to be watched in action. He studied their difficulties, and recorded their little triumphs of adaptation with an admiring smile. We owe as many discoveries to his sympathy with living nature as to his exactness or his candour, though these too were illustrious. It is not good to idolise even our greatest men, but we should try to profit by their example. I think that a young student, anxious to be useful but doubtful of his powers, may feel sure that he is not wasting his time if he is collecting or verifying facts which would have helped Darwin.

Zoologists may justify their favourite studies on the ground that to know the structure and activities of a variety of animals enlarges our sense of the possibilities of life. Surely it must be good for the student of Human Physiology, to take one specialist as an example of the rest, that he should know of many ways in which the same functions can be discharged Let him learn that there are animals (star-fishes) whose nervous system lies on the outside of the body, and that in other animals it is generally to be found there during some stage of development; that there are animals whose circulation reverses its direction at frequent intervals either throughout life (Tunicata) or at a particular crisis (insects at the time of pupation); that there are animals with eyes on the back (Oncidium, Scorpion), on the shell (some Chitonidæ), on limbs or limb-like appendages, in the brain-cavity, or on the edge of a protective fold of skin; that there are not only eyes of many kinds with lenses, but eyes on the principle of the pin-hole camera without lens at all (Nautilus) and of every lower grade down to mere pigment-spots; that auditory organs may be borne upon the legs (insects) or the tail (Mysis); that they may be deeply sunk in the body, and yet have no inlet for the vibrations of the sonorous medium (many aquatic animals). It is well that he should know of animals with two tails (Cercaria of Gasterostomum) or with two bodies permanently united (Diplozoon); of animals developed within a larva which lives for a considerable time after the adult has detached itself (some star-fishes and Nemertines); of animals which lay two (Daphnia) or three kinds of eggs (Rotifera); of eggs which regularly produce two (Lumbricus trapezoides) or even eight embryos apiece (Praopus[1]); of males which live parasitically upon the female (Cirripedes), or even undergo their transformations, as many as eighteen at a time, in her gullet (Bonellia); of male animals which are mere bags of sperm-cells (some Rotifera, some Ixodes, parasitic Copepods) and of female animals which are mere bags of eggs (Sacculina, Entoconcha). The more the naturalist knows of such strange deviations from the familiar course of things, the better will he be prepared to reason about what he sees, and the safer will he be against the perversions of hasty conjecture.

If a wide knowledge of animals is a gain to Physiology and every other branch of Biology, what opportunities are lost by our ignorance of the early stages of so many animals! They are often as unlike to the adult in structure and function as if they belonged to different genera, or even to different families. Zoologists have made the wildest mistakes in classifying larvæ whose subsequent history was at the time unknown. The naturalist who devotes himself to life-histories shares the advantage of the naturalist who explores a new continent. A wealth of new forms is opened out before him. Though Swammerdam, Réaumur, De Geer, Vaughan Thompson, Johannes Müller and a crowd of less famous naturalists have gone before us, so much remains to be done that no zealous inquirer can fail to discover plenty of untouched subjects in any wood, thicket, brook or sea.

Whoever may attempt this kind of work will find many difficulties and many aids. He will of course find abundant exercise for all the anatomy and physiology that he can command. He will need the systems of descriptive Zoology, and will often be glad of the help of professed systematists. The work cannot be well done until it is exactly known what animal is being studied. For want of this knowledge, hardly attainable 150 years ago, Réaumur sometimes tells us curious things which we can neither verify nor correct; at times we really do not know what animal he had before him. The student of life-histories will find a use for physics and chemistry, if he is so lucky as to remember any. Skill in drawing is valuable, perhaps indispensable.

If by chance I should be addressing any young naturalist who thinks of attending to life-histories, I would beg him to study his animals alive and under natural conditions. To pop everything into alcohol and make out the names at home is the method of the collector, but life-histories are not studied in this way. It is often indispensable to isolate an animal, and for this purpose a very small habitation is sometimes to be preferred. The tea-cup aquarium, for instance, is often better than the tank. But we must also watch an animal's behaviour under altogether natural circumstances, and this is one among many reasons for choosing our subject from the animals which are

[1] Hermann von Jhering, *Sitz. Berl. Akad.*, 1885; *Biol. Centralbl.*, Bd. vi. pp. 532-539 (1886).

locally common. Let us be slow to enter into controversies. After they have been hotly pursued for some time, it generally turns out that the disputants have been using words in different senses. Discussion is excellent, controversy usually barren. Yet not always; the Darwinian controversy was heated, and nevertheless eminently productive; all turns upon the temper of the men concerned, and the solidity of the question at issue. One more hint to young students. Perhaps no one ever carried through a serious bit of work without in some stage or other longing to drop it. There comes a time when the first impulse is spent, and difficulties appear which escaped notice at first. Then most men lose hope. That is the time to show that we are a little better than most men. I remember as a young man drawing much comfort from the advice of a colleague, now an eminent chemist, to whom I had explained my difficulties and fears. All that he said was: "Keep at it," and I found that nothing more was wanted.

I greatly believe in the value of association. It is good that two men should look at every doubtful structure and criticise every interpretation. It is often good that two talents should enter into partnership, such as a talent for description and a talent for drawing. It is often good that an experienced investigator should choose the subject and direct the course of work, and that he should be helped by a junior, who can work, but cannot guide. It seems to me that friendly criticism before publication is often a means of preventing avoidable mistakes. I am sorry that there should be any kind of prejudice against co-operation, or that it should be taken to be a sign of weakness. There are, I believe, very few men who are so strong as not to be the better for help. One difficulty would be removed if known authors were more generous in acknowledging the help of their assistants. They ought not to be slow to admit a real helper to such honour as there may be in joint-authorship.

Among the most important helps to the student of life-histories must be mentioned the zoological stations now maintained by most of the great nations. The parent of all these, the great zoological station at Naples, celebrated its twenty-fifth anniversary last April, so that the whole movement belongs to our own generation. How would Spallanzani and Vaughan Thompson and Johannes Müller have rejoiced to see such facilities for the close investigation of the animal life of the sea! The English-speaking nations have taken their fair share of the splendid work done at Naples, and it is pleasant to remember that Darwin subscribed to the first fund, while the British Association, the University of Cambridge and the Smithsonian Institution have maintained their own tables at the station.[1] The material support thus given is small when compared with the subsidies of the German Government, and not worth mention beside the heroic sacrifices of the Director, Dr. Anton Dohrn, but as proofs of lively interest in a purely scientific enterprise they have their value. Marine stations have now multiplied to such a point that a bare enumeration of them would be tedious. Fresh-water biological stations are also growing in number. Forel set an excellent example by his investigation of the physical and biological phenomena of the Lake of Geneva. Dr. Anton Fritsch of Prag followed with his movable station. There is a well-equipped station at Plön among the lakes of Holstein, and a small one on the Müggelsee near Berlin. The active station of Illinois is known to me only by the excellent publications which it has begun to issue. France, Switzerland, Sweden and Finland all have their fresh-water biological stations, and I hope that England will not long remain indifferent to so promising a sphere of investigation.

Biological work may answer many useful purposes. It may be helpful to industry and public health. Of late years the entomologist has risen into sudden importance by the vigorous steps taken to discourage injurious insects. I have even known a zoological expert summoned before a court of law in order to say whether or not a sword-fish can sink a ship. I would not on any account run down the practical applications of Biology, but I believe that the first duty of the biologist is to make science, and that science is made by putting and answering questions. We are too easily drawn off from this, which is our main business, by self-imposed occupations, of which we can often say nothing better than that they do no harm except to the man who undertakes them. There are, for example, a good many lists of species which are compiled without any clear scientific object. We have a better prospect of working to good purpose when we try to answer definite questions. I propose to spend what time remains in putting and answering as well as I can a few of the questions which occur to any naturalist who occupies himself with life-histories. Even a partial answer—even a mistaken answer is better than the blank indifference of the collector, who records and records, but never thinks about his facts.

The first question that I will put is this:—Why do some animals undergo transformation while others do not? It has long been noticed[1] that as a rule fresh-water and terrestial animals do not go through transformation, while their marine allies do. Let us take half a dozen examples of each:—

Fluviatile or terrestrial. Without transformation.	Marine. With transformation.
Crayfish.	Crab.
Earthworm.	Polygordius.
Helix.	Doris, Æolis.
Cyclas.	Oyster.
Hydra.	Most Hydrozoa.
&c.	&c.

We get a glimmer of light upon this characteristic difference when we remark that in fresh-water and terrestrial species the eggs are often larger than in the allied marine forms. A large egg favours *embryonic* as opposed to *larval* development. An embryo which is formed within a large egg may feed long upon the food laid up for it, and continue its development to a late stage before hatching. But if there is little or no yolk in the egg, the embryo will turn out early to shift for itself. It will be born as a larva, provided with provisional organs suited to its small size and weakness. Large eggs are naturally fewer than small ones. Does the size depend on the number, or the number on the size? To answer in a word, I believe that the size generally depends on the number, and that the number is mainly determined by the risks to which the species are exposed. At least so many eggs will in general be produced as can maintain the numbers of the species in spite of losses, and there is some reason to believe that in fresh waters the risks are less than in the shallow seas or at the surface of the ocean.[2] In most parts of the world the fresh waters are of small size, and much cut up. Every river-basin forms a separate territory. Isolation, like every other kind of artificial restriction, discourages competition, and impedes the spread of successful competitors. In the shallow seas or at the surface of the ocean conquering forms have a free course; in lakes and rivers they are soon checked by physical barriers.

A large proportion of animals are armour-clad, and move about with some difficulty when they have attained their full size. The dispersal of the species is therefore in these cases effected by small and active larvæ. Marine animals (whether littoral or pelagic) commonly produce vast numbers of locomotive larvæ, which easily travel to a distance. Floating is easy, and swimming not very difficult. A very slightly built and immature larva can move about by cilia, or take advantage of currents, and a numerous brood may be dispersed far and wide while they are mere hollow sacs, without mouth, nerves or sense-organs. Afterwards they will settle down, and begin to feed. In fresh waters armour is as common, for all that I know, as in the sea, but locomotive larvæ are rare.[3] There is no space for effective migration. Even a heavy-armoured and slow-moving crustacean or pond-snail can cross a river or lake, and to save days or hours is unimportant. In rivers, as Sollas has pointed out, free-swimming larvæ would be subject to a special risk, that of being swept out to sea. This circumstance may have been influential, but the diminished motive for migration is probably more important. At least an occasional transport to a new area is indispensable to most fresh-water organisms, and very unexpected modes of

1 To this list may now be added the University of Oxford.

1 Darwin, "Origin of Species," chap. xiii.; Fritz Müller, "Für Darwin," chap. vii.

2 Indications are given by the survival in fresh waters of declining groups, *e.g.* Ganoid Fishes, which, when dominant, maintained themselves in the sea; and by the not uncommon case of marine animals which enter rivers to spawn. I do not attempt to count among these indications the supposed geological antiquity of fluviatile as compared with marine animals. Some marine genera are extremely ancient (Lingula, Nucula, Trigonia, Nautilus); a perfectly fair comparison is almost impossible; and great persistence does not necessarily imply freedom from risks. In the Mollusca, which afford a good opportunity of testing the effect of habitat upon the number of the eggs, marine species seem to produce more eggs as a rule than fluviatile, and these many more than terrestrial species.

3 Dreyssensia and Cordylophora are examples of animals which seem to have quite recently become adapted to fresh-water life, and have not yet lost their locomotive larvæ. Many instances could be quoted of marine forms which have become fluviatile. The converse is, I believe, comparatively rare.

dispersal are sometimes employed, not regularly in each generation, but at long intervals, as opportunity offers.

Early migration by land is nearly always out of the question. Walking, and still more flying, are difficult exercises, which call for muscles of complex arrangement and a hard skeleton. A very small animal, turned out to shift for itself on land, would in most cases perish without a struggle. There might be just a chance for it, if it could resist superficial drying, and were small enough to be blown about by the wind (Infusoria, Rotifera, and certain minute Crustacea), or if it were born in a wet pasture, like some parasitic worms.

We can define two policies between which a species can make its choice. It may produce a vast number of eggs, which will then be pretty sure to be small and ill-furnished with yolk. The young will hatch out early, long before their development is complete, and must migrate at once in search of food. They will, especially if the adult is slow-moving or sedentary, be furnished with simple and temporary organs of locomotion, and will generally be utterly unlike the parent. The majority will perish early, but one here and there will survive to carry on the race.

Or the parent may produce a few eggs at a time, stock them well with yolk, and perhaps watch over them, or even hatch them within her own body. The young will in such cases complete their development as embryos, and when hatched, will resemble the parent in everything but size.

Which policy is adopted will largely depend upon the number of the family and the capital at command. There are animals which are like well-to-do people, who provide their children with food, clothes, schooling, and pocket-money. Their fortunate offspring grow at ease, and are not driven to premature exercise of their limbs or wits. Others are like starving families, which send the children, long before their growth is completed, to hawk matches or newspapers in the streets.

In Biology we have no sooner laid down a principle than we begin to think of exceptions. The exceptions may be apparent only; they may, when fully understood, confirm instead of disturbing the general principle. But this rarely happens unless the principle is a sound one *Exceptio probat regulam*; it is the exception which tests the rule, to give a new application to an old maxim.

Parasites form one group of exceptions to our rule. Whether they pass their free stages in air, water or earth, whether their hosts are marine, fluviatile or terrestrial, they are subject to strange transformations, which may be repeated several times in the same life-history. The change from one host to another is often a crisis of difficulty; many fail to accomplish it; those which succeed do so by means of some highly peculiar organ or instinct, which may be dropped as quickly as it is assumed. The chances of failure often preponderate to such an extent that an enormous number of eggs must be liberated. Even a brief parasitism may produce a visible effect upon the life-history. The young Unio or Anodon attaches itself for a short time to some fish or tadpole. To this temporary parasitism is due, as I suppose, the great number of eggs produced, and a degree of metamorphosis, unusual in a fresh-water mollusk.

The Cephalopoda, which are wholly marine, and the Vertebrates, whatever their habitat, very rarely exhibit anything which can be called transformation. Some few cases of Vertebrate transformation will be discussed later. Cephalopods and Vertebrates are large, strong, quick-witted animals, able to move fast, and quite equal in many cases to the defence of themselves and their families. They often produce few young at a time, and take care of them (there are many examples to the contrary among Cephalopods and Fishes). They are generally able to dispense with armour, which would have indirectly favoured transformation.

Echinoderms, which are all marine, develop with metamorphosis. There is an interesting exception in the Echinoderms with marsupial development, which develop directly, and give an excellent illustration of the effect of parental care.

Insects, which as terrestrial animals should lay a few large eggs, and develop directly, furnish the most familiar and striking of all transformations. I have already discussed this case at greater length than is possible just now (NATURE, December 19, 1895). I have pointed out that the less specialised insect-larvæ, *e.g.* those of Orthoptera, make a close approach to some wingless adult insects, such as the Thysanura, as well as to certain Myriopods. Fritz Müller seems to me to be right in saying that the larvæ of non-metamorphic insects come nearer than any winged insect to primitive Tracheates. The transformation of the Bee, Moth, or Blow-fly is transacted after the stage in which the normal Tracheate structure is attained, and I look upon it as a peculiar *adult* transformation, having little in common with the transformations of Echinoderms, Mollusks, or Crustaceans.

In the same way I believe that some Amphibia have acquired an adult transformation. Frogs and toads, having already as tadpoles attained the full development of the more primitive Amphibia, change to lung-breathing, tailless, land-traversing animals, able to wander from the place of their birth, to seek out mates from other families, and to lay eggs in new sites.

Medusæ furnish a third example of adult transformation, which seems to find its explanation in the sedentary habit of the polyp, which probably nearly approaches the primitive adult stage. But here the case is further complicated, for the polyp still proceeds from a planula, which is eminently adapted for locomotion, though perhaps within a narrower range. We have two migratory stages in the life-history. Each has its own advantages and disadvantages. The planula, from its small size, is less liable to be devoured, or stranded, or dashed to pieces, but it cannot travel far; the medusa may cross wide seas, but it is easily captured and is often cast up upon a beach in countless multitudes.

Adult transformation may be recognised by its occurrence after the normal structure of the group has been acquired, and also by its special motive, which is egg-laying and all that pertains to it; the special motive of larval transformation is dispersal for food.

The reproduction of the common Eel has been a mystery ever since the days of Aristotle, though a small part of the story was made out even in ancient times. It was long ago ascertained that the Eel, which seeks its food in rivers, descends to the sea in autumn or early winter, and that it never spawns, nor even becomes mature in fresh waters. The Eels which descend to the sea never return, but young eels or Elvers come up from the sea in spring, millions at a time. The Elvers have been seen to travel along the bank of a river in a continuous band or eel-rope, which has been known to glide upwards for fifteen days together. It was, of course, concluded that spawning and early development took place in the sea during the interval between the autumn and spring migration, but no certain information came to hand till 1896. Meanwhile this gap in our knowledge was a perplexity, almost a reproach to zoologists. The partially-known migration of the Eel could not be harmonised with the ordinary rule of migratory fishes. We tried to explain the passage of marine fishes into rivers at spawning time by the supposition (a true supposition, as I think) that the river is less crowded than the shallow seas, and therefore a region in which competition is less severe. The river is to some migratory fishes what the tundras of Siberia are to some migratory birds, places comparatively free from dangerous enemies, and therefore fit for the rearing of the helpless young. But the Eel broke the rule, and cast doubt upon the explanation. The Salmon, Sturgeon and Lamprey feed and grow in the sea, and enter rivers to spawn. The Eel feeds and grows in rivers, but enters the sea to spawn. What possible explanation could meet cases thus diametrically opposite?

This was the state of matters when Grassi undertook to tell us that part of the history of the Eel which is transacted in the sea. When it leaves the river, it makes its way to very deep water, and there undergoes a change. The eyes enlarge, and become circular instead of elliptical; the pectoral fins and the border of the gill-cover turn black; the reproductive organs, only to be discovered by microscopic search before this time, enlarge. The Eels, thus altered in appearance and structure, lay their eggs in water of not less than 250 fathoms' depth. The upper limit of the spawning-ground is nearly three times as far from sea-level as the 100-fathom line which we arbitrarily quote as the point at which the deep sea begins. The eggs, which are large for a fish (2·7 mm. diam.), float but do not rise. The young which issue from them are quite unlike the Eels of our rivers; they are tape-like, transparent, colourless, devoid of red blood, and armed with peculiar teeth. A number of different kinds of such fishes had been previously known to the naturalist as Leptocephali. Günther had conjectured that they were abnormal larvæ, incapable of further development. Grassi has, however, succeeded in proving that one of these Leptocephali (*L. brevirostris*) is simply a larval Eel; others are larvæ of Congers and various Murænoid fishes. He has with infinite

pains compared a number of Leptocephali, and coordinated their stages, making out some particularly important ones by the direct observation of live specimens.

You will not unnaturally ask how Grassi or anybody else can tell what goes on in the sea at a depth of over 250 fathoms. His inquiries were carried on at Messina, where the local circumstances are very fortunate. Strong currents now and then boil up in the narrow strait, sweeping to the surface eggs, larvæ, and a multitude of other objects which at ordinary seasons lie undisturbed in the tranquil depths. Further information has been got by dredging, and also by opening the body of a sun-fish (*Orthagoriscus mola*), which at certain times of the year is taken at the surface, and is always found to contain a number of Leptocephali. When a Leptocephalus has completed its first stage of growth, it ceases to feed, loses bulk, and develops pigment on the surface of the body. At the same time the larval teeth are cast, and the larval skeleton is replaced. Then the fish begins to feed again, comes to the surface, enters the mouth of a river, and, if caught, is immediately recognised as an Elver or young Eel. It is now a year old, and about two inches long.

This history suggests a question. Are the depths of the sea free from severe competition? The darkness, which must be nearly or altogether complete, excludes more than the bare possibility of vegetation. A scanty subsistence for animals is provided by the slowly-decomposing remains of surface-life. When the dredge is sunk so low, which does not often happen, it may bring up now and then a peculiar and specially modified inhabitant of the dark and silent abyss. There cannot, we should think, be more than the feeblest competition where living things are so few, and the mode of life so restricted. Going a step further, we might predict that deep-sea animals would lay few eggs at a time, and that these would develop directly—*i.e.* without transformation. The risk of general reasoning about the affairs of living things is so great that we shall hold our conjectures cheap unless they are confirmed by positive evidence. Happily this can be supplied. The voyage of the *Challenger* has yielded proof that the number of species diminishes with increasing depth, and that below 300 fathoms living things are few indeed.[1] Dr. John Murray gives us the result of careful elaboration of all the facts now accessible, and tells us that the majority of the abyssal species develop directly (NATURE, March 25, 1897).

We seem, therefore, to have some ground for believing that the depths of the sea resemble the fresh waters in being comparatively free from enemies dangerous to larvæ. The Eel finds a safe nursery in the depths, and visits them for the same reason that leads some other fishes to enter rivers. It may be that the depths of the sea are safer than rivers, in something like the same degree and for the same reasons that rivers are safer than shallow seas. But we must be careful not to go too fast. It may turn out that deep recesses in the shallower seas—holes of limited extent in the sea-bottom—enjoy an immunity from dangerous enemies not shared by the great and continuous ocean-floor.[2]

After this short review of the facts I come to the conclusion that the general rule which connects the presence or absence of transformation with habitat is well-founded, but that it is apt to be modified and even reversed by highly special circumstances. The effect of habitat may, for instance, be over-ruled by parasitism, parental care, a high degree of organisation, or even by a particular trick in egg-laying. The direct action of the medium is probably of little consequence. Thus the difference between fresh and salt water is chiefly important because it prevents most species from passing suddenly from one to the other. But the abyssal and the fluviatile faunas have much in common, as also have the littoral and the pelagic faunas. Relative density and continuity of population seem to be of vital importance, and it is chiefly these that act upon the life-history.

In Zoology, as in History, Biography, and many other studies, the most interesting part of the work is only to be enjoyed by those who look into the details. To learn merely from text-books is notoriously dull. The text-book has its uses, but, like other digests and abridgments, it can never inspire enthusiasm. It is the same with most lectures. Suppose that the subject is that well-worn topic, the Alternation of Generations. The name recalls to many of us some class-room of our youth, the crudely coloured pictures of unlikely animals which hung on the walls, and the dispirited class, trying to write down from the lecture the irreducible minimum which passes a candidate. The lecturer defines his terms and quotes his examples; we have Salpa, and Aurelia, and the Fern, and as many more as time allows. How can he expect to interest anybody in a featureless narrative, which gives no fact with its natural circumstances, but mashes the whole into pemmican? What student goes away with the thought that it would be good and pleasant to add to the heap of known facts? The heap seems needlessly big already. And yet every item in that dull mass was once deeply interesting, moving all naturalists and many who were not naturalists to wonder and delight. The Alternation of Generations worked upon men's minds in its day like Swammerdam's discovery of the butterfly within the caterpillar, or Trembley's discovery of the budding Hydra, which when cut in two made two new animals, or Bonnet's discovery that an Aphis could bring forth living young without having ever met another individual of its own species. All these wonders of nature have now been condensed into glue. But we can at any time rouse in the minds of our students some little of the old interest, if we will only tell the tale as it was told for the first time

Adalbert Chamisso, who was in his time court-page, soldier, painter, traveller, poet, novelist, and botanist, was the son of a French nobleman. When he was nine years old, he and all the rest of the family were driven out of France by the French Revolution. Chamisso was educated anyhow, and tried many occupations before he settled down to Botany and light literature. In 1815 he embarked with Eschscholtz on the Russian voyage round the world commanded by Kotzebue. The two naturalists (for Chamisso is careful to associate Eschscholtz with himself, and even to give him priority) discovered a highly curious fact concerning the Salpæ, gelatinous Tunicates which swim at the surface of the sea, sometimes in countless numbers. There are two forms in the same species, which differ in anatomical structure, but especially in this, that one is solitary, the other composite, consisting of many animals united into a chain which may be yards long. Chamisso and Eschscholtz ascertained that the solitary form produces the chain-form by internal budding, while the chain-form is made up of hermaphrodite animals which reproduce by fertilised eggs.[1] There is thus, to use Chamisso's own words, "an alternation of generations. . . . It is as if a caterpillar brought forth a butterfly, and then the butterfly a caterpillar." Here the phrase *bring forth* is applied to two very different processes, viz. sexual reproduction and budding. Chamisso's phrase, "alternation of generations," is not exact. Huxley would substitute *alternation of generation with gemmation*, and if for shortness we use the old term, it must be with this new meaning. Subsequent investigation, besides adding many anatomical details, has confirmed one interesting particular in Chamisso's account, viz that the embryo of Salpa is nourished by a vascular placenta.[2] The same voyage yielded also the discovery of Appendicularia, a permanent Tunicate tadpole, and the first tadpole found in any Tunicate.

Some ten years after the publication of Chamisso's alternation of generations in Salpa, a second example was found in a common jelly-fish (Aurelia). Not a few Hydrozoa had by this time been named, and shortly characterised. Some were polyps, resembling the Hydra of our ponds, but usually united into permanent colonies; others were medusæ, bell-shaped animals which swim free in the upper waters of the sea. It was already suspected that both polyps and medusæ had a common structural plan, and more than one naturalist had come very near to knowing that medusæ may be the sexual individuals of polyp-colonies.

This was the state of matters when an undergraduate in Theology of the University of Christiania, named Michael Sars, discovered and described two new polyps, to which he gave the names, now familiar to every zoologist, of Scyphistoma and Strobila. In the following year (1830) Sars settled at Kinn, near Bergen, as parish priest, and betook himself to the life-long study of the animals of the Norwegian seas. He soon found out that his Scyphistoma was merely an earlier stage of his Strobila. Scyphistoma has a Hydra-like body, less than half an inch long,

1 *Challenger* Reports. "Summary of Scientific Results" (1895), pp. 1430–96.

2 I am aware that other things affect the interests of animals, and indirectly determine their structure, besides danger from living enemies. So complicated a subject can only be discussed in a short space if large omissions are tolerated.

1 Brooks maintains that the solitary Salpa, which is female, produces a chain of males by budding, and lays an egg in each. These eggs are fertilised while the chain is still immature, and develop into females (solitary Salpæ). The truth of this account must be determined by specialists.

2 Cuvier had previously noted the fact.

and drawn out into a great number of immensely long tentacles. It buds laterally like a Hydra, sending out stolons or runners, which bear new polyps, and separate before long, the polyps becoming independent animals. In the midst of the tentacles of the scyphistoma is a prominence which bears the mouth. This grows upwards into a tall column, the strobila, which is supported below by the scyphistoma. When the strobila is well nourished it divides into transverse slices, which at length detach themselves, and swim away.[1] These are the Ephyræ, which had been found in the sea before Sars' time, and were then counted as a particular kind of adult medusæ. They are small, flat discs with eight lobes or arms, all notched at the extremity. A pile of ephyræ is produced by the transverse constriction and division of the strobila in a fashion which reminds us of the rapid production of the animals in a Noah's ark by the slicing of a piece of wood of suitable sectional figure. It was thus ascertained that the scyphistoma, strobila, and ephyra are successive stages of one animal, but for a time no one could say where the scyphistoma came from, nor what the ephyra turned to. At length Sars, aided by the anatomical researches of Ehrenberg and Siebold, was able to clear up the whole story. The ephyra is gradually converted by increase of size and change of form into an Aurelia, a common jelly-fish which swarms during the summer in European seas. The Aurelia is of two sexes, and the eggs of the female give rise to ciliated embryos, which had been seen before Sars' time, but wrongly interpreted as parasites or diminutive males. These ciliated embryos, called planulæ, swim about for a time, and then settle down as polyps (scyphistomata). There is thus a stage in which Aurelia divides without any true reproductive process, and another stage in which it produces fertile eggs. There is alternation of generations in Aurelia as well as in Salpa, and Sars was glad to fortify by a fresh example the observations of Chamisso, on which doubts had been cast.

It was not long before the alternation of generations was recognised in Hydromedusæ also, and then the ordinary Hydrozoan colony was seen to consist of at least two kinds of polyps, one sexual, the other merely nutrient, both being formed by the budding of a single polyp. The sexual polyp, or medusa, either swims away or remains attached to the colony, producing at length fertilised eggs, which yield planulæ, and these in turn the polyps which found new colonies.

Those of us who are called upon to tell this story in our regular course of teaching should not forget to produce our scyphistoma, strobila and ephyra; the interest is greatly enhanced if they are shown alive. It is not hard to maintain a flourishing marine aquarium even in an inland town, and a scyphistoma may be kept alive in an aquarium for years, budding out its strobila every spring.

Alternation of generations, when first announced, was taken to be a thing mysterious and unique. Chamisso brought in the name, and explained that he meant by it a metamorphosis accomplished by successive generations, the form of the animal changing not in the course of an individual life, but from generation to generation (*forma per generationes, nequaquam in prole seu individuo, mutata*). Sars adopted Chamisso's name and definition. Steenstrup a little later collected and discussed all the examples which he could discover, throwing in a number which have had to be removed again, as not fairly comparable with the life-histories of Salpa and Aurelia. He emphasised the alternation of budding with egg-production, and the unlikeness in form of the asexual and sexual stages. Like Chamisso, he carefully distinguished between development with metamorphosis and alternation of generations. All three naturalists, Chamisso, Sars and Steenstrup, laid stress on this point. In an insect, they would have said, there is development with metamorphosis. The same animal passes from larva to pupa, and from pupa to imago. In Aurelia or Salpa, however, the animal which lays eggs is not the animal which buds, but its progeny. The cycle of the life-history includes two generations and many individuals.

This view has spread very widely, and if we were to judge by what is commonly taught, I think that we should recognise this as the doctrine now prevalent. It is however, in my opinion, far inferior as an explanation of the facts to that adopted by Leuckart, Carpenter and Huxley, who regard the whole cycle, from egg to egg, as one life-history. Huxley and Carpenter, differing in this from Leuckart, do not shrink from calling the whole product of the egg an animal, even though it consists of a multitude of creatures which move about and seek their food in complete independence of one another. Rather than ignore the unity of the life-history of Aurelia or Salpa, they would adopt the most paradoxical language. This attitude was forced upon them by the comparative method. They refused to study Aurelia, for example, as an animal apart; it had its near and its remoter relatives. Among these is the freshwater Hydra, which develops without transformation, buds off other Hydras when food is plentiful, and at length becomes sexually mature. Budding is here a mere episode, which may be brought in or left out, according to circumstances. The same individual polyp which buds afterwards produces eggs. The life-history of Salpa cannot be traced with equal facility to a simple beginning, for it presents points of difficulty, on which the learned differ. In the Polychæt Worms, however, we find a beautiful gradation leading up to alternation of generations. We begin with gradual addition of new segments and increasing specialisation of the two ends of the body, the fore end becoming non-reproductive, and the hinder end reproductive. Then we reach a stage (Syllis) in which the reproductive half breaks off from the fore part, and forms (after separation) a new head, while the fore part adds new segments behind. In Autolytus the new head forms before separation, and many worms may cohere for a time, forming a long chain with heads at intervals. In Myrianida the worms break up first, and afterwards become sexually mature. We should gather from these cases that alternation of generations may arise by the introduction of a budding-stage into a development with transformation. The polyp or worm buds while young and lays eggs at a later time. The separation of the two processes of reproduction often becomes complete, each being restricted to its own place in the life-history. As a rule the worm or polyp will bud while its structure is uncomplicated by reproductive organs. It is easy to propagate some plants by cutting one of the leaves into sections, and making every section root itself, and grow into a new plant; but we can seldom do the same thing with a flower. There may therefore be a distinct advantage to particular animals and plants in dividing the life-history into two stages, an earlier budding, and a later egg-laying stage.

The advantage to be drawn from budding is easily seen in those animals which find it hard to gain access to a favourable site. Thus a Tænia[1] is very lucky when it establishes itself in the intestine. Once there, it goes on budding indefinitely. It is harder to trace the advantage in the case of many polyps, though some (Cunina, &c.) admit of the same explanation as Tænia. There are yet other cases (some Worms, Salpæ, &c.) in which our ignorance of the conditions of life renders a satisfactory explanation impossible at present.

The budded forms often differ in structure from the budding forms which produce them, and many writers and teachers make this difference part of the definition of alternation of generations. I think that Leuckart has suggested a probable explanation in his essay of 1851,[2] which is still thoroughly profitable reading. He attributes the peculiarities of the larva mainly to the circumstance that it is turned out at an early age to shift for itself. In the budded forms there is no such necessity. The parent has established itself on a good site which commands a sufficiency of food. Until it has done this, it does not bud at all. The young which it produces asexually need not disperse in infancy, at least until crowding sets in. The tradesman who has founded a business puts his elder boys into the shop; perhaps the younger ones may be obliged to try their luck in a distant town. The budded forms, reared at the cost of the parent, may therefore omit the early larval stages at least, and go on at once to a later or even to the final stage. Thus the head of Tænia, when it has fixed itself in the intestine, produces sexual segments; the redia of Distomum produces cercariæ or more rediæ, omitting the locomotive embryo; the scyphistoma produces ephyræ. The saving of time must often be great, and the days saved are days of harvest. Think how much a tree would lose if in the height of summer it were unable to bud, and could only

[1] Leuckart (*Zeits. f. wiss. Zool.*, Bd. iii. p. 181) remarks that elongate animals tend to divide transversely or to bud axially, while broad animals tend to divide longitudinally or to bud laterally. The question has been raised more than once whether the division of the strobila is not really a case of budding. Leuckart shows that budding and fission cannot be separated by any definition; they pass insensibly into one another ("Wagner's Handb. d. Physiol.," art. "Zeugung").

[1] This case is quoted by Leuckart.

[2] "Ueber Metamorphose, ungeschlechtliche Vermehrung, Generationswechsel," *Zeits. f. wiss. Zool.*, Bd. iii. Equally important is the same author's treatise, "Ueber den Polymorphismus der Individuen oder die Erscheinung der Arbeitstheilung in der Natur," Giessen, 1851.

propagate by seeds. If the budded forms are sexual, while the budding forms are not, there is an obvious explanation of the difference in form. Even where there is no such fundamental difference in function, the circumstances of early life are very different, and may well produce an unlikeness upon which Natural Selection may found a division of labour.

No one who tries to trace origins can rest satisfied with Steenstrup's account of alternation of generations. He makes no effort to show how it came about. Instead of considering alternation of generations as a peculiar case of development with metamorphosis, complicated by asexual reproduction,[1] he considers asexual reproduction as a peculiar case of alternation of generations.[2] He ignores all the facts which show that the alternation may have been gradually attained, an omission which is only excusable when we note that his treatise is dated 1842. He asserts dogmatically that there is no transition from metamorphosis to alternation of generations.

It is impossible to think much on this subject without falling into difficulties over the word *generation*. For my own part I believe that such words as *generation*, *individual*, *organ*, *larva*, *adult* cannot be used quite consistently in dealing with a long series of animals whose life-histories vary gradually and without end. Ordinary language, which was devised to meet the familiar and comparatively simple course of development of man and the domestic animals, is not always appropriate to lower forms, with complex and unusual histories. If we are resolved at all hazards to make our language precise and uniform, we either fall into contradictions, or else use words in unnatural senses.

Certain recent discussions render it necessary to point out that there can be no alternation of generations without increase by budding. If a single larva produces a single sexual animal, as when a pluteus changes to an Echinus, there is development with transformation, but not alternation of generations.

It is, I think, of importance to be able to resolve so peculiar a phenomenon as alternation of generations into processes which are known to occur separately, and which may have arisen imperceptibly, becoming gradually emphasised by the steady action of the conditions of life. Every startling novelty that can thus be explained extends the application of that principle which underlies the theory of Natural Selection—I mean the principle that a small force acting steadily through a long time may produce changes of almost any magnitude.

The Hydrozoa yield innumerable and varied examples of development with transformation and also of budding. They yield also the most admirable examples of division of labour. We have Hydrozoan colonies, such as a budding Hydra, in which all the members are pretty much alike, but we soon advance to differentiation of the feeding and the reproductive members. In the Siphonophora the colony becomes pelagic, and floats at the surface of the sea. Then the medusæ no longer break off and swim away, but are harnessed to the colony; and drag it along. The colony may contain feeding polyps, which procure and digest food for the rest; swimming bells, which are attached medusæ; perhaps a float, which is a peculiar kind of swimming bell; defensive polyps (which may be either batteries of nettling cells or covering organs); and reproductive individuals. As the individuals become subordinated to the colony, and lose essential parts of the primitive structure, they pass insensibly into organs.

The life-histories of Invertebrates abound in complications and paradoxes. Thus Eucharis, one of the Ctenophors, becomes sexually mature as a larva, but only in warm weather. This happens just after hatching, when the animal is of microscopic size. Then the sexual organs degenerate, the larva, which has already reproduced its kind, grows to full size, undergoes transformation, and at length becomes sexually mature a second time.[3] There is often a striking difference between the early stages of animals which are closely related, or a strong adaptive resemblance between animals which are of very remote blood-relationship. In the Hydrozoa similar polyps may produce very different medusæ, and dissimilar polyps medusæ that can hardly be distinguished. There are insects so like in their adult state that they can only be distinguished by minute characters, such as the form and arrangement of the hairs on the legs, and yet the larvæ may be conspicuously different.[1] Annelids and Echinoderms yield fresh examples of the same thing. In Lepidoptera and Saw-flies the larvæ are very similar, but the winged insects quite different.[2] New stages may be added in one species, while closely allied species remain unaffected. In Cunina and the Diphyidæ we get combinations which strain the inventive powers of naturalists even to name. Natural Selection seems to act upon the various stages of certain life-histories almost as it acts upon species.

But the history is not always one of growing complexity. Sometimes, for example, a well-established medusa-stage is dropped. First it ceases to free itself, then the tentacles and marginal sense-organs disappear, then the mouth closes. In the fresh-water Cordylophora the medusa is replaced by a stalked sac filled with reproductive elements or embryos. The Lucernariæ present a single stage which seems to be polyp and medusa in one. Hydra has no medusa. It is not always clear whether such Hydrozoa as these are primitive or reduced. Even the hydroid polyp, the central stage in the normal Hydrozoan life-history, may be suppressed, and certain medusa in both of the chief groups develop direct from the egg or planula (Pelagia, Geryonia, Ægina, Oceania). There is no stage common to all Hydrozoa except the egg. The same thing may be said of the Tunicates.

The life-history of many Arthropods is to all appearance quite simple. There emerges from the egg a spider, scorpion, or centipede (in most Chilopoda) which merely grows bigger and bigger till it is adult. But if, as in most Crustacea, the circumstances of the species call for a migratory stage, such a stage will be added. In certain Decapod Crustacea (Penæus, Leucifer) a nauplius and as many as five other stages may intervene before the final or adult stage. Some of these larval stages are common to a great many Crustacea, but none, as we now think, belong to the original phylogeny. If a resting or a winged stage is wanted, it is supplied just as easily; witness the holometabolic insects. Here again, so far as we know, there is nothing absolutely new.[3] The stages which seem new are merely exaggerations for special purposes of sections of the life-history, which were originally marked out by nothing more important than a change of skin and a swelling out of the body. Let us not suppose for a moment that it is a law of insect-development that there should be larva, pupa, and imago, or that it is a law of Crustacean development that there should be six distinct stages between the egg and the adult. Any of these stages may be dropped, if it proves useless—either totally suppressed, or telescoped, so to speak, into the embryonic development. Lost stages are indicated by the embryonic moults of some centipedes and spiders, Limulus, many Crustacea, and Podura. The parthenogenetic reproduction of some immature insects, such as Miastor, shows a tendency to suppress later stages. Perhaps the wingless Thysanura are additional examples, but here, as in the case of Hydra and Lucernaria, we do not certainly know whether they are primitive or reduced. It seems to be easy to add new stages, when circumstances (and especially parasitism) call for them. Meloe, Sitaris, and Epicauta are well-known examples. In some Ephemeridæ the moults, which are potential stages, become very numerous, but as a curious exception to a very general rule, the last moult of all, which is usually so important, may be practically suppressed. The fly of an Ephemera may mate, lay eggs, and die, while still enveloped in its last larval skin.

Among the many cases of what one is inclined to call *rapid* adaptation to circumstances (the chief indications of *rapidity* being the very partial and isolated occurrence of remarkable adaptive characters) are those which Giard[4] has collected and compared, and which he refers to a process called by him Pœcilogony. A number of very different animals[5] produce according to habitat, or season, or some other condition closely related to nutrition, eggs of more than one sort, which differ in the quantity of nourishment which they contain and in the degree of transformation which the issuing larva is destined to undergo. The analogy with the summer and winter eggs of

[1] This is a convenient short account of Alternation of Generations, but it will not apply to every case. In Hydra, for instance, there is an ill-defined alternation of generations, but no metamorphosis.
[2] *Cf.* Leuckart, *loc. cit.*, p. 183.
[3] Chun, *Die pelagische Thierwelt*, p. 62 (1887).

[1] Some species of Chironomus are referred to.
[2] Baron Osten Sacken (*Berl. Entom. Zeits.*, Bd. xxxvii. p. 465) gives two cases of Diptera, in which "almost similar larvæ produce imagos belonging to different families."
[3] "Nirgends ist Neubildung, sondern nur Umbildung."—Baer.
[4] C. R. 1891, 1892.
[5] *E.g.* Crustacea (Palæmonetes, Alpheus), Insects (*Musca corvina*, some Lepidoptera and Diptera), an Ophiurid (Ophiothrix), a Compound Ascidian (Leptoclinus), &c

Daphnia, &c., cannot escape notice, and Giard connects with all these the pædogenesis of Miastor and Chironomus, and many cases of heterogony. For our immediate purpose it is sufficient to remark that the reproductive processes and the course of development are as liable to vary for motives of expediency as the form of a leg or fin. The supposed constancy (the *necessary* constancy according to some naturalists) of the embryonic stages throughout large groups, would not be hard to break down, if it were to be again asserted. Probably the doctrine is now totally abandoned; it belongs to that phase of zoological knowledge in which Meckel could declare that every higher animal passes in the course of its development through a series of stages which are typified by adult animals of lower grade, and when an extreme partisan, far inferior to Meckel both in experience and caution, could affirm that the human embryo omits no single lower stage.

The tadpole-larva, which is common in lower Vertebrates and their allies, shows the influence of adaptation as strongly as any larva that we know. We may describe the tadpole as a long-tailed Chordate, which breathes by gills and has a suctorial mouth-disc, at least during some part of its existence. It is a cheap form of larva, when reduced to its lowest terms, requiring neither hard skeleton, nor limbs, nor neck, yet it can move fast in water by means of its sculling tail. Such a tadpole appears in many life-histories, and plays many parts. The tadpole is the characteristic Tunicate larva, and in this group commonly ends by losing its tail, and becoming fixed for life. But Salpa, which is motile when adult, has lost its tadpole. Appendicularia has lost the normal adult stage if it ever had one, and its tadpole becomes sexually mature. The same thing seems to have happened to many Amphibia, whose tadpoles acquire legs, become sexually mature, and constitute the normal adult stage. The Lamprey, as Balfour and others have recognised, is another kind of sexually mature tadpole. Thus the tadpole may act as larva to a sea-squirt, fish (Acipenser, Lepidosteus, Amia), or frog; it may also constitute the only remaining stage in the free life-history.

The lower and smaller animals seem to show beyond others the prevalence of adaptive features. They offer visible contrivances of infinite variety, while they are remarkable for the readiness with which new stages are assumed or old ones dropped, and for their Protean changes of forms, which are so bewildering that many Worms, for instance, cannot as yet be placed at all, while many larvæ give no clue to their parentage. These lower and smaller animals show beyond others a tendency to multiply rapidly, and to break away from one another in an early stage. The tendency is so strong in the microscopic Protozoa that it enters into the definition of the group. Fission, budding, alternation of generations, and spore-formation (as in Gregarina) are ultimately due to the same tendency.

Weak animals are almost inevitably driven to scatter, and to make up by their insignificance, their invisibility, and their powers of evasion for the lack of power to resist. It is a great thing to a Hydrozoan colony that if one polyp is bitten off, others remain, that no enemy can possibly devour all the medusæ liberated from one colony, or all the planulæ liberated from one medusa. Low organisation gives very special facilities for extreme division. There are animals and plants which multiply greatly as a consequence of being torn to pieces or chopped small. (Chigoe, some Fungi, &c.)

Small animals are usually short-lived. Many complete their life-history in a few weeks. Those which last for so long as a year are often driven, like annual plants, to adapt every detail of their existence to the changing seasons. The naturalist who explores the surface waters of the sea with a tow-net soon learns that the time of year determines the presence or absence of particular larvæ. It is probably as important to an Aurelia as to a butterfly that it should tide over the storms of winter by means of a sedentary and well-protected stage. Any one who keeps scyphistoma in an aquarium will remark how small it is, how it creeps into crevices or the hollows of dead shells. But when the depth of winter is past, it pushes out its strobila, which in spring liberates ephyræ. These rapidly enlarge, and by August have grown from microscopic discs to jelly-fishes a foot across.

The intelligence of many small animals is very low. They go on doing the thing that they have been used to do, the thing that has commended itself to the experience of many generations. They are governed by routine, by that inherited and unconscious power of response to external stimulus, which we call instinct. But there are some notable exceptions. Of all small animals, insects seem to show the greatest flexibility of intelligence.

There is one large group of animals which is in striking contrast to nearly all the rest. Vertebrates, and especially the higher Vertebrates, are usually big and strong. They rely upon skill, courage, or some other product of high organisations, rather than upon numbers and fertility. Vertebrates swallow many other animals, together with their living parasites, but are rarely swallowed alive or fresh by Invertebrates. This fact of nature has led to many consequences, among others to this, that many parasites which pass their earlier stages in the bodies of Invertebrates only attain sexual maturity in a Vertebrate host. The complexity of the structure of a Vertebrate precludes the possibility of multiplication by breaking-up or budding, and they multiply only by egg-laying or strictly analogous processes. The higher Vertebrates live so long that the accidents of a particular year or a particular season are not of vital importance. Hence seasonal transformation is almost unknown; the quadruped or bird may choose the warm months for rearing the family, or celebrate the pairing season by getting a new suit of feathers, or grow a thicker coat against the cold of winter, but that is all. No Vertebrates perish regularly at the approach of winter, leaving only batches of eggs to renew the species in spring, nor is their structure profoundly modified by the events of the calendar (the frog is a partial exception). One minor cause of transformation, which affects the life-history of many polyps, worms and insects, is thus removed. Vertebrates often take care of their young, and the higher Vertebrates bring forth few at a time. For this reason among others they rarely afford examples of free larvæ. Such Vertebrate larvæ as we do find conform to the Vertebrate type. It is often impossible to predict what adult will develop from an Invertebrate larva, but no one could hesitate to rank an Ammocoetes, a Leptocephalus, or a tadpole among the Vertebrates.

It accords with this strength and mastery that Vertebrates, and especially the higher Vertebrates, should be more stable, more conservative, less experimental than other animals. They retain ancient structures long after they have ceased to be useful. The gill-clefts, gill-arches, and branchial circulation are good examples. Though not functional in Sauropsida and Mammalia, they never fail to appear in the course of the development. Yet the Sauropsida and the Mammalia are positively known to go back to the earliest secondary and late palæozoic times. Ever since the beginning of the secondary period at least, every reptile, bird, and mammal has continued to pass through a stage which seems obviously piscine, and of which no plausible explanation has ever been offered, except that remote progenitors of these animals were fishes. Could not Natural Selection, one is tempted to ask, have straightened the course of development during lapses of time so vast, and have found out less roundabout ways of shaping the tongue-bone and the ossicles of the ear? Either it costs nothing at all to pursue the old route, or it costs nothing which a higher Vertebrate will ever miss. The second alternative seems to me the more likely. The Sauropsida and Mammalia, in comparison with other animals, are particularly well off, and like wealthy housekeepers, they do not care what becomes of the scraps. It is, I fancy, different with many fishes, which show, by their numerous eggs, the occasional presence of peculiar immature stages, and some other slight hints, that their life is a hard one.

The presence in the developing reptile, bird, or mammal of piscine structure which are no longer useful has been ascribed to a principle called Recapitulation, and Haeckel lays it down as a fundamental biogenetical law that the development of the individual is an abbreviated recapitulation of the development of the race. If I had time to discuss the Recapitulation Theory, I should begin by granting much that the Recapitulationist demands—for instance, that certain facts in the development of animals have an historical significance, and cannot be explained by mere adaptation to present circumstances; further, that adaptations tend to be inherited at corresponding phases both in the ontogeny and the phylogeny. I am on my guard when he talks of *laws*, for the term is misleading, and ascribes to what is a mere general statement of observed facts the force of a command. The so-called laws of nature (a phrase to be avoided) may indeed enable us to predict what will happen in a new case, but only when the conditions are uniform and simple—a thing which is common in Physics, but very

rarely in Biology. I diverge from him when he says that "each animal is compelled to discover its parentage in its own development," that "every animal in its own development repeats this history, and climbs up its own genealogical tree." When he declares that "the proof of the theory depends chiefly on its universal applicability to all animals, whether high or low in the zoological scale, and to all their parts and organs,"[1] I feel persuaded that, if this is really so, the Recapitulation Theory will never be proved at all. The development, so far as it has yet been traced, of a Hydra, Peripatus, Beetle, Pond-mussel, Squid, Amphioxus, Chick or Mammal tells us very little indeed of the history of the races to which they belong. Development tells us something, I admit, and that something is welcome, but it gives no answer at all to most of the questions that we put. The development of a Mammal, for instance, brings to light what I take to be clear proof of a piscine stage; but the stage or stages immediately previous can only be vaguely described as Vertebrate, and when we go back further still, all resemblance to particular adult animals is lost. The best facts of the Recapitulationist are striking and valuable, but they are much rarer than the thorough-going Recapitulationist admits; he has picked out all the big strawberries, and put them at the top of the basket. I admit no sort of necessity for the recapitulation of the events of the phylogeny in the development of the individual. Whenever any biologist brings the word *must* into his statement of the operations of living nature, I look out to see whether he will not shortly fall into trouble.

This hasty review of animal transformations reminds me how great is the part of adaptation in nature. To many naturalists the study of adaptations is the popular and superficial side of things; that which they take to be truly scientific is some kind of index-making. But we should recognise that comparatively modern adaptations may be of vital importance to the species, and particularly luminous to the student because at times they show us nature at work.

I am accustomed to refer such adaptations to the process of Natural Selection, though if any one claimed to explain them by another process, I should, for present purposes, cheerfully adopt a more neutral phrase. There are, I believe, no limits to be assigned to the action of Natural Selection upon living plants and animals. Natural Selection can act upon the egg, the embryo, the larva, and the resting pupa, as well as upon the adult capable of propagation. It can even influence the race through individuals which are not in the line of descent at all, such as adults past bearing or the neuters of a colony. The distinction between historical and adaptive, palingenetic and cœnogenetic, is relative only, a difference not of kind but of degree. All features are adaptive, but they may be adapted to a past rather than to a present state of things; they may be ancient, and deeply impressed upon the organisation of the class.

In Biology facts without thought are nothing; thought without facts is nothing; thought applied to concrete facts may come to something when time has sorted out what is true from what is merely plausible. The Reports of this Association will be preserved here and there in great libraries till a date when the biological speculations of 1897 are as extinct as the Ptolemaic Astronomy. If many years hence some one should turn over the old volumes, and light upon this long-forgotten address, I hope that he will give me credit for having seen what was coming. Except where the urgent need of brevity has for the moment been too much for scientific caution, I trust that he will find nothing that is dogmatic or over-confident in my remarks.

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY G. F. DEACON, M.INST.C.E., PRESIDENT OF THE SECTION.

IN this ever-memorable year of the Victorian Age, it is not unnatural that any one called to fill the chair I occupy to-day should experience a sense of oppression, when contemplating the fruits of mechanical science during the last sixty years, and the tremendous vista, fading in the distance to a dream, of the fruits it is destined to produce before such another period shall have passed away.

There would be no possibility, in the time at my disposal, even if I were qualified to attempt it, of adequately reviewing the past; and however fascinating the thought may be, it would ill become my office to venture far along the vista before us, lest a too airy imagination should break the bonds of that knowledge and that truth to which she must ever remain, in our rightful speculations, a helpful, if not always an obedient, handmaiden.

In the year 1831, two places, the one ancient and memorable, the other young, but destined to become memorable, bore the name of York. At the first of these, amid relics of ancient Rome and lasting memorials of the better phases of Britain's mediæval history, were met together in that year the earliest members of the British Association. And as the sun at noon-day shone on that ancient York, it rose upon the other York—a little town, scarcely more than a village, of 1700 people, fast springing from a plain on the shores of Ontario, where the wigwam of the Chippewa had lately been; and between the two two lay the Atlantic and a distance of 4000 miles.

Sixty-six years later, the British Association meets in that other York, distinguished under the name of Toronto, and grown into a noble city. Painfully, in stage coaches, must many of the founders of this Association have travelled to that ancient York; peacefully and amid all comfort and luxury have we from the mother country reached, at her invitation, this great city—chiefest, in its people, its commerce, and its University, of the cities of Western Canada.

Neither at the meeting in York of 1831, nor elsewhere, until many years later, was there any expectation of the possibility of these things. Six years later, about the beginning of that glorious reign of which the sixty-first year is now passing—although two or three vessels had already crossed the Atlantic under steam, it was still seriously doubted whether, without the aid of a Government subsidy of considerable amount, a line of steamers, even for the New York service, could be permanently maintained. It was not, indeed, until 1838 that the *Great Western* inaugurated the attempt on a commercial basis, and she performed in fifteen days the voyage which is now regularly performed with complete commercial success in five.

Would not the suggestion of such a change, of such a spanning of great distances, of such a consequent growth of prosperity and of culture, within the reign of a princess then approaching womanhood, have been received as the wildest of forecasts by the British Association of 1831?

Yet this is but one of a multitude of results, no less startling, which the same agencies have brought about. We are now holding the second meeting of the Association in Canada, and at the first such meeting, held thirteen years ago in Montreal, some hundreds of miles nearer home, Sir Frederick Bramwell told you from this chair, in his own inimitable way, the causes of so great a change, and he pointed out to you, as I venture to point out again, that the visible instruments of that change have been forged by the men who are, or were, or ought to be, the members of Section G. To such encouragement as Section G has given is largely due the progress and triumph of applied mechanics as the natural outcome of theoretical investigation and physical research. Finally, and with no reserve in the minds of reasonable men, the old fallacy of a discord between theory and practice has been swept away. For centuries that fallacy held apart, as it were, the oxygen and the nitrogen of that atmosphere in which alone the new life could exist. It limited the philosopher who examined the laws of nature almost entirely to the study of phenomena external to the earth on which he dwelt, and it stamped the practical man as a lower being, the possessor of certain necessary knowledge, having no relation to the studies of the schoolmen, and which it would be beneath their dignity to pursue. And notwithstanding the great names which have stood out in opposition to these views, the popular idea of discord between theory and practice took long to die, and only within the Victorian Age has the complete truth been generally recognised, that if one fails to account for the result of any physical combination, the cause is to be found not in any discord with theory, but in the fact that the observer has failed to discover the whole of the theory.

We English-speaking people, alone, I believe, among civilised nations, use this word, *theory*, with unpardonable looseness—as almost synonymous in effect with *hypothesis*, and the result is fruitful of error. Until the truth of any hypothesis

[1] The quotations are from the late Prof. A. Milnes Marshall's Address to Section D, British Association Report, 1890, which states the Recapitulationist case with great knowledge and skill.

is placed beyond all manner of doubt it is not, and should never be called, the theory.

Within these walls, the *genius loci* impels me to thoughts which have not often entered into discussions of Section G; and, perhaps, if this address were to be discussed, I should choose subjects and premises, the proof of which, to the satisfaction of others than myself, it would probably be less difficult to maintain. In this University of Toronto under whose *ægis* all that was best in the older schools of thought is cultivated by the side of those practical applications of science which in bygone days were distinguished as the unworthy uses of philosophy, one's thoughts insensibly turn to the marvellous change in the opportunities afforded for acquiring a knowledge of applied science—for becoming, in short, an engineer.

It is not proposed to discuss the progress and prosperity which mechanical science has brought about in the Victorian Era, much less that which the succeeding years will yield; but I venture to think that a proper subject for consideration from this chair, if not for discussion in this Section, is to be found in any unnecessary waste of energy which may occur in the process of mental development of the men who are to succeed us in the great work to which we devote our lives. Obviously it is to the interests of our calling, and consequently of the nation at large, that such waste should be reduced to a minimum, and therefore I make no apology for mentioning certain points in which its presence is particularly striking. There may be waste of potential, as well as of actual energy, and if we fail to expend energy on certain subjects because our time is occupied with others which are less useful, it is waste of energy only differing in degree from its expenditure on useless subjects. There is assuredly no lack of potential energy in the coming race. In spite of any training, whether well or ill directed, a large proportion will become actual and useful energy; but guidance and direction being given, the mode of that guidance and direction should be the one best calculated to secure the highest possible proportion of useful effect.

If we look back at the greatest names among the engineers and inventors of the latter part of the eighteenth century and the first half of this, we find that the majority were brought up in pursuits quite distinct from the work of their after lives, and by which they have become so familiar to us. There were scarcely any means whatever, beyond the original thought and dogged perseverance of the worker, by which those men could attain the knowledge they used with such effect. Men of no less exceptional parts are among us now, but the whole environment of their early work has changed. We have given to the exceptional man a starting-point of knowledge which, wisely used, lifts him as high above our heads as of old, but we have given to the average man a comparatively easy means of attaining the same knowledge. We cannot ensure the wise use of that knowledge, but we can at least endeavour to impart it in such a manner that the sense of right proportion shall be acquired and maintained. We have made it more difficult to distinguish between the exceptional and the commonplace—between the gold and the silver, if not between the silver and the brass; let us be careful, so far as early guidance can control it, that the knowledge imparted to the average mind gives to that mind a fair start concerning the relations, undivided and indivisible, between true theory and sound practice.

Having myself passed as an ordinary apprentice through workshops of mechanical engineering in the old days when working hours were longer than they now are—from six in the morning till six in the evening, and that, too, on the banks of the Clyde, where no special indulgence was given to what was sometimes called the "gentleman apprentice," and feeling convinced, as I still do, of the immense and permanent advantage derived from that experience, I shall not be judged to underrate its value in the case of others who have yet to choose the details of the career by which they expect to gain a place in the profession or business of an engineer.

On the other hand, as a student thirty-four years ago under the late Prof. Macquorn Rankine and the present Lord Kelvin, I shall not be prone to under-estimate the advantages of academical training in its proper application to the profession to which I am proud to belong.

In the pursuit of that profession it has fallen to my lot to observe the training as engineers of many younger men—men of variously constituted minds, but one and all bent on learning some portion of "the art of directing the great sources of power in nature for the use and convenience of man," words wisely chosen, sixty-nine years ago, and set out as the object of the profession in the Royal Charter of the Institution of Civil Engineers. It is a noble object, this *direction of the great forces of nature for the use and convenience of man*; it is an ambitious object, and one which I venture to think demands for its right performance the best energies of well-balanced minds working upon a store of knowledge which nothing but years of untiring study and observation can give. Yet there is no hesitation shown to enter the lists. The number of candidates is appalling. In the old country, at least, there certainly is not work for all, but when one points this out, anxious parents only reply that the difficulty is as great in connection with any other profession. Whether this be so or not I cannot judge, but I am persuaded that of those who do enter the business or profession of the engineer, the enormous majority are not born engineers, and cannot, in the nature of things, hope for success unless they take advantage of the best facilities open to them—the *best facilities*: here is the difficulty: from the multitude of facilities how are we to choose?

Do not suppose that I think the training of the born engineer should not be controlled. He will stand head and shoulders above the rest of us whatever we may do with him; but in order that his exceptional parts may not wreck him as an engineer, and in order that his energies may be rightly directed at the start, he, too, should have the advantages of that systematic training which to his less gifted brethren is becoming more and more absolutely essential to success.

At the time I began practice the large majority of young engineers were left entirely to their own devices so far as the attainment of any scientific knowledge was concerned. As pupils or apprentices, articled or not, they entered an engineer's works or office; for a certain number of years they had the run of the place and some encouragement if they worked well, but it could not, in the nature of things, amount to much more. This was a very necessary, perhaps the most necessary, element of their training; but except to the few who were so constituted that with little or no guidance they could supplement their practical knowledge with the study of principles elsewhere, it was entirely ineffectual in the production of that well-balanced attitude of mind which any person who properly assumes the name of an engineer must hold towards every engineering problem, great or small, which he is called upon to solve. And so strongly have I felt this, that in the earlier days, when there were fewer schools of practical science, and when their utility was little understood, I required, wherever the matter was under my control, the insertion into the articles of apprenticeship of a clause by which, at some inconvenience to the office, the pupil was required to attend two sessions at the science classes of Glasgow University, or at some other approved school of practical science; and without this condition I declined to take the responsibility attaching to the introduction into the profession of men who, in their earlier careers, from no fault of their own, had not even acquired a knowledge of what there was to learn, much less of how to learn it.

More recently this course has generally become unnecessary; for in Westminster, at least, the young engineer rarely enters an office until he has acquired some knowledge of what he has to learn. He enters, in short, at a much more advanced age than formerly. When it is essential that he should be earning something soon after he comes of age, anything like a complete training is an impossibility; his work ceases to be general, and his practice is more or less confined in a much narrower sphere than need be the case if the pursuit of further knowledge continues to be his chief duty.

But whatever course his circumstances may permit him to adopt, the difficulty of gaining the required knowledge in the time available is a serious one. This is not the place to inquire whether public school education in the mother country is, or is not, the best for the general purposes of after life, or to discuss what improvements may be made in it; and of higher education in Canada I unfortunately know little or nothing. Personally I admit the possibility of improvement in the English system, and slowly but surely improvement is creeping in, as such changes rightly find their way into institutions which have done so much for Englishmen. In this particular I lean to the conservative side, and whatever our individual views may be concerning the time spent on the study of Latin and Greek, we should all probably agree that the school education of an engineer should be as thorough and liberal as for any other profession. But for the sake of a technical training to follow, this school education

is often unduly curtailed, to the great after-grief, in very many cases, of the successful engineer, and not infrequently also of the less successful engineer who, in some phases of his professional career, has been only too keenly alive to the self-reproach and sense of inferiority which want of thoroughness or of time, or of both, at school has brought upon him.

But at some time the boy must leave school. Let us hope that he does not aspire "to control the great forces of nature"; but if he does we must make the best we can of him.

It is not desirable, at least so it appears to me, that even at this stage his training should be specialised in view of the particular branch of the profession or business he is likely to follow. The fundamental principles of any branch of mechanical engineering are broadly the fundamental principles of any branch of the profession. I hesitate to speak of civil engineering as if it were a separate branch, instead of being, as it really is, the generic name of the profession; but the training demanded for the various branches of civil engineering in its narrower sense is precisely the same as that required in its earlier stages for mechanical engineering pure and simple.

I shall make no attempt to review the large number of excellent courses which are now available for the teaching of applied science in relation to engineering. Experience of the results as judged by the students who have come directly under my notice, and examination of many calendars, has aroused various thoughts concerning them, and this thought is perhaps uppermost: *are we not in some cases attempting at too early a stage the teaching of subjects instead of principles?* attempting at too early a stage the teaching of subjects instead of principles? Complete subjects, I mean, including the practical working of details which will become the regular study of the student in the office or works of an engineer. It certainly seems to me to be so. I do not say that subject training of this kind at college may not be useful; but we have to consider whether it does not, for the sake of some little anticipation of his office work, divert the attention of the student from the better mastery of those principles which it is so essential for him to grasp at the earliest possible time, and which do not limit his choice in the battle of life to any branch whatever of the profession or business of an engineer, but which, on the contrary, qualify him better to pursue with success whatever branches his inclination or his opportunities or his means may suggest. Not one in a hundred of us can hope to emulate the careers of exceptional men in our profession, but it is sometimes useful to observe those careers, and whenever we do so we find the very reverse of specialisation. The minds of such men are impregnated with the fundamental principles which we may call the common law of our art; it has happened that their practice has been large in certain branches, and small or wanting in certain others; but in any it would have been equally successful. Of no class of men can it be said with greater truth than of engineers that their standard should be sound knowledge of the principles of many things and of the practice of a few.

There is some danger in the usual limitation of compulsory subjects in examinations for certificates and degrees. When an examination has to be passed subjects not made compulsory are too often entirely neglected, however important to the engineer they may be. A little learning is certainly not a dangerous thing if within its limits it is sound, and every engineer will in after life be grateful to those who in his student days insisted upon his acquiring some knowledge of the principles of such subjects as electricity and chemistry. At present it too often happens that, unless an engineering student is predestined to practise electrical work or some chemical industry, he begins life as an engineer with no knowledge of the principles of either the one or the other, and chiefly as a result of their neglect for the sake of certain subjects made compulsory for the test he has had to pass, which subjects too occasionally include the highly specialised favourites of a particular professor or verge too completely on perfected details which, I venture to think, cannot be rightly mastered in schools. It is natural and right that each professor of a principal subject should seek to make the best, from his own particular standpoint, of every student who attends his lectures or his laboratories; and the professor of a compulsory subject cannot be expected to encourage the inclusion, in a course already overcrowded, of secondary or collateral subjects which are dealt with by other professors; while, on the other hand, the professors of secondary subjects, such as electricity or chemistry, not unnaturally value chiefly the students who make those subjects their principal work.

For these reasons it appears to me that a certain very moderate standard in all such subjects should be made compulsory if a certificate of proficiency, whether by degree or otherwise, is to be given in engineering or even in physical science.

In the teaching of mathematics within the Victorian Age a considerable change has taken place, and I plead for still a little more change in the same direction where the training of the engineer is concerned. Mathematics, as taught in our public schools—let us say for the Cambridge University Tripos—may be all that is claimed for it as a mode of mental culture; but of kindred mental culture the engineer must necessarily have more than most men, and much might therefore be omitted which, to him at least, has only an abstract value, to the great advantage of his mastery over those branches which at once train his mind and give point and direct utility to his solutions.

In America I understand that a college course of engineering generally includes workshop practice designed to supersede the old system of apprenticeship to a mechanical engineer. This fact and other important differences between the English and American practice have only lately come to my knowledge, and before they did so the substance of this address had been written. It might, in some particulars, require modification as applied to Canada, but it remains the result of my observations concerning the conditions of engineering education which obtain in the mother country.

A few words now in relation to that physical and mental training gained laboriously, and somewhat wastefully as I think, at the joiner's bench, in the fitting and turning shops, the foundry and the forge, during the old course of mechanical engineering apprenticeship. I am convinced that the kind of knowledge which comes of thoughtful chipping and filing and turning and forging, though only applied to a few of the materials with which in after life the engineer has to deal, are quite as important as tables of density and strength to his future sense of rightness in constructive design. The use of such work is not merely to teach one the parts and combinations of any particular machine; in a still higher degree it is the insensible mastery of a much more subtle knowledge or mental power, the application of the senses of sight and touch and force, it may be of other senses also, to the determination of the nature of things. (I am not going to apologise for referring to the *sense of force*. The vexed question of its separate existence appears to me to have been settled fourteen years ago by Lord Kelvin in his address at Birmingham on "the six gateways of knowledge," and I may well leave it where he left it.) I should altogether fail to describe adequately what this mastery means. It appears to me to be inscrutable. The value and nature of the power can only be appreciated by those who have experienced it, and who have felt its defect in those of their assistants or in others who do not possess it.

But the great workshop training has still further advantages. The apprentice is surrounded by skilled workers from whose example, if he is wise, he learns a great deal; and apart from this it is no small profit to have rubbed against the British workman, to have discovered what manner of man he is, and to comprehend how little the world knows of his best parts. The whole time spent in large engineering works cannot, however, be equally beneficial; the apprentice must take the work as it comes; the most interesting or instructive portions cannot be reserved for him, and he often feels that some of his time is being well-nigh wasted.

A few years ago I should not have thought it practicable usefully to substitute for such a course anything that could be undertaken in a student's workshop, however organised; but the impossibility, in many cases, of including such experience without neglecting something equally important has led me to view with satisfaction the introduction of workshop training into certain schools of applied science in England. Such a change cannot, of course, carry with it all the advantages of experience in the great workshop and of contact with its workers, but those advantages which it does retain may be secured in a shorter time where there is no commercial interest to be served.

In Canada and the United States, as I have already said, the principle of the student's workshop has been carried considerably further. Compared with the old country, I believe the number of young assistant engineers who in proportion to the number of their chiefs can find employment in America is much greater, and that it would be practically impossible for the British system of pupilage to be generally employed. Here, therefore, the whole college training of an engineer is designed to fit him for

immediate employment in some specific branch of the profession, and up to this point his training is, necessarily no doubt, more academic than in England, where the application of the principles he has acquired at college is still generally left for the office or works of the engineer. With this difference I am not at present concerned, but I desire to reiterate what I have already said to the effect that where, as in England, the student of engineering has the opportunity of continuing his training in the office or works, it is better that his limited college course should cover all that is possible of the principles of those sciences which may prove useful or necessary to him in after life, rather than that any of them should be omitted for the sake of anticipating the practical application of certain others.

The compulsory inclusion of the principles of all such subjects as chemistry, electricity, geology, and many others, in science courses intended for a future engineer is desirable not only because a fundamental knowledge of them leaves open a very much wider field from which the engineer may, as opportunity offers, increase his knowledge and practice in the future, but because many of such subjects are inseparable from an intelligent understanding of almost any great engineering work. "Nothing so difficult as a beginning" may be a proverb of rather too far-reaching a nature, but it contains the suggestion of a great truth, increasing in weight as we grow older, and the beginnings of such collateral sciences should therefore find a place in every engineering student's store of early knowledge.

But after all, when these things have been done in the best manner—when the scientific and practical training of the engineering student has been all that can be desired, it is a matter of general experience among engineers who have closely watched the rising generation, that the most successful men in after life are not produced exclusively from the ranks of those whose college course has been most successful. No doubt such men have on the average been nearer the top than the bottom, but it is an undoubted fact that when we class them according to their earlier successes or failures, we find the most remarkable disparities. We find many who in academic days gave but little promise, and we miss large numbers who promised great things. These facts are not confined to the profession of the engineer, but they seem to me to be accentuated in that profession. We shall no doubt be right in attributing the disparity to differences of mental temperament and of opportunity; but does it follow that there are no faculties which may be cultivated to reduce the effect of such differences? I venture to think there are. I will instance only one, but perhaps the most important of such faculties, and which in my experience among young engineers is exceptionally rare. I refer to the power of marshalling facts, and so thinking, or speaking, or writing of them that each maintains its due significance and value.

In the minds of many young engineers a mathematical training undoubtedly has the effect of making it extremely difficult to avoid spending an amount of time upon some issues out of all proportion to their importance; while other issues which do not readily lend themselves to mathematical treatment, but which are many times more important, are taken for granted upon utterly insufficient data, and chiefly because they cannot be treated by any process of calculation. I believe that nothing but well-directed observation and long experience can enable one to assign to each part of a large engineering problem its due importance; but much may be done in early training also, and I think ought to be done, to lead the mind in broader lines, to accustom it to look all round the problem, and to control the imagination or the natural predilection for one phase from disguising the real importance of others. In the practical design and execution of important works the man will sooner or later be recognised who has the power so to formulate his knowledge, and on the same principles has succeeded in so marshalling and expressing his thoughts, as to convey to those by whom he is employed just so much as may be necessary and proper for their use.

Such considerations are not, it is true, a branch of mechanical science, but being essentially important to the attainment of maximum usefulness in the application of any science to the various branches of engineering which are the chief ends and aims of mechanical science, they are, I think, worthy of mention from this chair.

In proportion as the engineer possesses and exercises such powers he will avoid those innumerable pitfalls to which imperfectly instructed ingenuity is so particularly liable, and to which the Patent Office is so sad a witness; and in the same proportion must always be the useful outcome of the great schools of science which have become so striking a feature of the later Victorian Age.

In relation to the results of applied science, I have spoken only of the steamship; add the telegraph, and I think we have the most important tools by which the present conditions of modern civilisation have been rendered possible. And more than this, I think we have, in the lessening of space, and the facility for intercourse they give, the chief secret of that marvellous development of the empire which this year has so pleasantly and so memorably signalised. Is "Our Lady of" the Sunshine and "the Snows" no nearer to the mother land than sixty years ago? Are the Australias—New Zealand—no nearer to both? Assuredly they are. Would British Africa, would the Indian Empire have been possible to Britain on the principles and the methods of Imperial Rome? Unquestionably not. Then let me say again that I claim for the objects and the work of Section G a magnificent record, an abiding power for the peace of the world, and for the unity and prosperity of the great empire to which we belong.

THE AMERICAN ASSOCIATION.

THE meeting of the American Association for the Advancement of Science, held at Detroit August 9-13, though the smallest since 1879, was, as many small meetings are, one of the most interesting and important.

Much disappointment was felt at the absence of President Wolcott Gibbs, owing to the condition of his health and his advanced age, which forbade him making so long a journey. In his absence Prof. Wm. J. McGee occupied the chair.

A feature of the meeting was the forecast of a jubilee celebration at Boston next year, for which Prof. Putnam, Secretary of the Association, has secured a wealth of invitations from all governmental, educational, and scientific organisations situated at Boston; and the election of Prof. Putnam himself, after a quarter of a century of service, to preside at the great Boston meeting, which promises to be a very great scientific gathering.

A memorial address on the life and work of the late president of the Association, Prof. Edward D. Cope, was delivered by Prof. Theodore Gill, and is printed in full in *Science*. The address concluded with the following reflections upon the place which Cope must be assigned in the history of science:—

"Among those that have cultivated the same branches of science that he did—the study of the recent as well as the extinct Vertebrates—three naturalists have acquired unusual celebrity. Those are Cuvier, Owen, and Huxley.

"Cuvier excelled all of his time in the extent of his knowledge of the anatomical structure of animals and appreciation of morphological details, and first systematically applied them to, and combined them with, the remains of extinct Vertebrates, especially the mammals and reptiles. He was the real founder of Vertebrate palæontology.

"Owen, a disciple of Cuvier, followed in his footsteps, and, with not unequal skill in reconstruction and with command of ampler materials, built largely on the structure that Cuvier had begun.

"Huxley covered as wide a field as Cuvier and Owen, and likewise combined knowledge of the details of structure of the recent forms with acquaintance with the ancient ones. His actual investigations were, however, less in amount than those of either of his predecessors. He excelled in logical and forcible presentation of facts.

"Cope covered a field as extensive as any of the three. His knowledge of structural details of all the classes of Vertebrates was probably more symmetrical than that of any of those with whom he is compared; his command of material was greater than that of any of the others; his industry was equal to Owen's; in the clearness of his conceptions he was equalled by Huxley alone; in the skill with which he weighed discovered facts, in the aptness of his presentation of those facts, and in the lucid methods by which the labour of the student was saved and the conception of the numerous propositions faciliated he was unequalled. His logical ability may have been less than that of Huxley and, possibly of Cuvier. He has been much blamed on account of the constant changes of his views and because he was inconsistent. Unquestionably he did change his views very often. Doubtless some of those changes were

necessitated by too great haste in formulation and too great rashness in publication. The freedom to change which he exercised, and which was exercised too little by at least one of his predecessors, was an offset to his rashhess. He exercised a proper scientific spirit in refusing to be always consistent at the expense of truth."

We have received copies of addresses delivered before some of the sections :—"A Chapter in the History of Mathematics" was the subject of an address delivered before the section of Mathematics and Astronomy, by Prof. W. W. Beman. An interesting address was delivered before the section of Physics, by the vice-president, and chairman of the section, Dr. Carl Barus, upon the subject of "Long Range Temperature and Pressure Variables in Physics." The section of Chemistry received an address from Prof. W. P. Mason, upon "Expert Testimony," which is practically a handbook for experts. Prof. J. Galbraith addressed the section of Mechanical Science and Engineering, upon "The Groundwork of Dynamics." The section of Botany listened to an address upon "Experimental Morphology," by Prof. G. F. Atkinson.

Papers of interest were presented in each section. The Physics section was unusually full, and received a large proportion of electrical papers. Two professors from the Weather Bureau read papers : Prof. Frank H. Bigelow, on international cloud observations made by that bureau ; and Prof. C. F. Marvin, on kites and their use by the bureau in exploring the upper air. One or two joint sessions of this section and the mathematical section were held. Several joint sessions of other sections took place. A debate on evolution was conducted before the joint session of botanical and zoological sections by Prof. Henry F. Osborn and Prof. E. B. Poulton. The zoological section was specially interested in the notes on a collection of Cephalopods from the *Albatross* expedition, by Mr. Wm. E. Hoyle, Keeper of the Manchester Museum. Prof. L. O. Howard was elected vice-president of this section, to fill the vacancy caused by death of Prof. G. Brown Goode. Prof. Howard's address as vice-president was on the distribution of species by man, with particular reference to insects. He also read other papers; and was elected permanent secretary of the Association, in place of Prof. Putnam.

A joint session of the geological and anthropological sections was held to discuss the discoveries of argillite implements near Trenton, by Prof. Putnam. Profs. Putnam and Wright maintained that these discoveries proved the existence of palæolithic man ; an inference disputed by others.

Startling conclusions with reference to the region where the Association met, were presented to the geologists by Dr. J. W. Spencer and Prof. G. K. Gilbert, who by joint labour and investigation had determined that the earth's surface about the great lakes is sinking at nearly the rate of one inch in ten years, as Dr. Spencer says. Prof. Gilbert adds that the rise is more rapid towards the north and east, amounting to five inches in a century in points 100 miles apart. The result will be that in a few centuries Chicago and Detroit will be flooded ; within 1000 years water will flow freely from Lake Michigan into the Mississippi, and within 3000 years Niagara will be dry, and the St. Lawrence will drain only the Lake Ontario basin. Prof. E. W. Claypole was elected to preside over this section in the absence of the vice-president.

The time and place of the next meeting, fifty years after the formation of the Association, will be Boston, August 22, 1898 ; at which city arrangements were made in 1847 to meet at Philadelphia in 1848, and then to change the old Association of American Geologists and Naturalists into the American Association for the Advancement of Science.

The following were nominated as officers : President, Prof. Frederick Ward Putnam, of Cambridge, Mass. Permanent Secretary, Prof. Leland O. Howard, of Washington, D.C., Government entomologist. General Secretary, Prof. D. S. Kellicott, of Columbus, Ohio. Secretary of the Council, Prof. Frederick Bedell, of Ithaca. Treasurer, Prof. R. S. Woodward, of New York. Vice-Presidents : Section A (Mathematics and Astronomy), Prof. E. E. Barnard, of the University of Chicago ; Section B (Physics), Prof. Frank D. Whitman, of Cleveland, Ohio ; Section C (Chemistry), Prof. Edgar F. Smith, of Philadelphia ; Section D (Mechanical Science and Engineering), Prof. Wm. E. Cooley, of Ann Arbor ; Section E (Geology and Geography), Prof. H. L. Fairchild, of Rochester, N.Y. ; Section F (Zoology), Prof. A. S. Packard, junr., of Providence, R.I. ; Section G (Botany), Prof. W. G. Farlow, of Harvard University ; Section H (Anthropology), Prof. J. M. Cattell, of New York ; Section I (Economic Science and Statistics), Mr. Archibald Blue, of Toronto, Canada. Secretaries of Sections : Section A, Prof. Alexander Ziwet, of Ann Arbor ; Section B, Prof. E. B. Rosa, of Middletown, Conn. ; Section C, Prof. Charles Baskerville, of the University of North Carolina ; Section D, Prof. W. S. Aldrich, of Morgantown, W.Va. ; Section E, Prof. Warren Upham, of St. Paul, Minn. ; Section F, Mr. C. W. Stiles, of Washington, D.C. ; Section G, Mr. Erwin Smith, of Washington, D.C. ; Section H, Dr. M. H. Saville, of New York ; Section I, Dr. Marcus Benjamin, of Washington, D.C.

NOTES.

As already announced, the sixty-ninth meeting of German men of science and physicians will take place at Brunswick on September 20 to 25. On the Sunday before, September 19, there will be a display of popular and juvenile games on the Bernhard Platz, in the afternoon. In the evening the first general reception will take place. There will be two general meetings, on September 20 and 24 respectively, at 9 a.m. Prof. Richard Meyer (Brunswick) will give a paper on the relations between chemical research and chemical technology, and Prof. Waldeyer (Berlin) on impregnation and heredity, on the Monday. At Friday's meeting, September 24, there will be a lecture by Dr. Orth (Göttingen), on medical instruction and practice ; and by Dr. H. Meyer (Leipzig), on the sources of the Xingu river, Central Brazil. The sections will begin to meet on Monday afternoon, September 20, but on Wednesday there will be a joint meeting of the sections on the subject of scientific photography, for which some highly interesting papers are promised by Prof. H. W. Vogel, René du Bois-Reymond, Lassar, Selenka, and others. The evenings throughout the week will be enlivened by operas, concerts, and balls, and excursions are arranged to Wolfenbüttel, Königslutter, and other attractive places in the neighbourhood.

THE Imperial Leopold-Carolina Academy of Halle has awarded the Gold Comenius Medal to Prof. A. von Kölliker, professor of anatomy in Würzburg University, who recently celebrated the completion of his eightieth year and the jubilee of his appointment to the chair he occupies.

IT is announced in the *Times* that Sir Robert Giffen, K.C.B., F.R.S., Controller-General of the Commercial, Labour, and Statistical Department of the Board of Trade, having reached the age at which he is at liberty to retire from the Civil Service, has decided to do so. The Board of Trade will thus lose his invaluable services ; but Sir Robert Giffen will be given more leisure to complete some important studies upon which he has lately been engaged.

IT is stated that Prof. Koch is about to return to South Africa to carry out further experiments in relation to rinderpest.

THE *British Medical Journal* states that one hundred sets of Röntgen ray apparatus are to be supplied to the Army Medical Department.

WE learn from the *Revue Scientifique* that the late M. J. Jackson left a sum of one hundred thousand francs to each of the following organisations :—Société nationale d'acclimatation, Société de linguistique, Société géologique de France, Société française de photographie, Association française pour l'avancement des sciences, Société astronomique de France.

WE regret to announce the following deaths :—Dr. Karl Vogel and Prof. Wilhelm Liebenow, the veteran German cartographers ; Prof. Karl Wilhelm Petzold, of Brunswick, known by his works on physical and astronomical geography ; Dr. Theophil Chudzinski, a member of the Paris Anthropological Society, and a frequent contributor to its bulletins and the *Revue d'Anthropologie* ; Dr. J. H. Trumbull, a distinguished philologist

and a member of the U.S. National Academy of Sciences, and Dr. Jules Bernard Luys, member of the Paris Academy of Medicine.

The National Photographic and allied Trades Exhibition will be held in the Portman Rooms, Baker Street, London, W., in April next. It is to be a manufacturers' exhibition of photographic, lantern and optical apparatus and accessories, and it will be open to the public as well as to dealers. Mr. Arthur C. Brookes is the acting secretary to the exhibition, and applications for space should be addressed to him at Temple House, Temple Avenue, London, E.C.

The State of Indiana has undertaken to defray the expense of publishing annually the *Proceedings* of the Indiana Academy of Science, and the two reports, for the years 1894 and 1895, for the printing and publication of which the State has paid, have just come to hand. By publishing the proceedings of the Academy the State secures, without further expenditure, the service of a number of investigators working in various departments of science, and spending a large portion of their time upon new problems the solution of which is of importance to the development of the Indiana commonwealth. These investigators, who constitute the best authority in the State upon their several subjects, will act without pecuniary compensation with the legislative body of Indiana, just as the National Academy of Sciences acts in conjunction with the U.S. Congress; they will freely advise the legislators when consulted upon scientific subjects, and assist in giving direction to scientific investigations undertaken by the Legislature as a basis for logical laws. The work of an Academy like the Indiana Academy is an important factor in developing mineral, vegetable, and animal resources, and it greatly strengthens educational agencies. The State has thus acted wisely in giving encouragement to the scientific workers within its borders, and doubtless the funds it has undertaken to provide will be returned a thousand-fold.

The recent meeting of the Association of Agricultural Colleges and Experiment Stations in the United States cannot fail to be productive of good. "It brings out forcibly," says the *American Naturalist*, "the endeavours of Americans as a people to ameliorate the conditions of the agricultural classes, reminding us, as it does, that some 1,890,000 dols. were granted by Congress for the fiscal year ending June 30, 1898, for agriculture.. Of this, something like 1,170,000 dols. is for scientific investigations under the direct supervision of the Department of Agriculture, and the rest (720,000 dols.) for maintaining the experiment stations. The departmental divisions falling within the domains covered by the American naturalist receive various amounts as follows: botany, 23,800 dols.; agrostology, 18,100 dols.; forestry, 28,520 dols.; pomology, 14,500 dols.; physiology and vegetable pathology, 26,500 dols.; biological survey, 27,560 dols.; entomology, 29,500 dols.; the bureau of animal industry, 755,640 dols.; and for special investigations in nutrition, under the auspices of the office of experiment stations, 15,000 dols."

Fourteen electric cabs commenced to "ply for hire" in the streets of London as ordinary licensed hackney carriages on Friday last. The *Electrician* gives the following particulars of the new vehicles:—The battery used on each of the vehicles consists of a set of 40 accumulator cells having a capacity of 170 ampere-hours when discharged at a rate of 30 amperes. It is estimated that on the level the current required, when the controller is placed at "full speed," is 24 amperes, and that on a fair incline, at about one-third that speed, this current is not exceeded. Steeper gradients require up to 30 or 35 amperes. The battery is carried in a tray, which is slung under the bottom of the cab by four suspension links supported by springs under compression, and the ordinary carriage springs again separate the cells from the vibration to which the carriage wheels are exposed. The motors have been specially designed for these cabs. They are of the Johnson-Lundell type, and supplied from America. The fields have two similar windings, and the armatures have also two similar sets of windings and two commutators. This doubly-wound motor is connected to a series-parallel controller of the usual American pattern in exactly the same way as the two motors of a tramcar would be connected to it. The cabs can be made to run at about one, three, seven, or nine miles an hour, and can move backwards. The whole of the movements are produced by the use of one lever placed at one side of the driver's box. It was originally estimated that two sets of cells would be required to enable the cab to do an ordinary day's work in the streets of London, it being considered that one set would propel it about thirty-five miles. The economy of the motor and controller arrangements, however, is so considerable that it is now found the cabs will do at least fifty miles with one set of cells without recharging, and the economy in the use of current thus experienced will make the running of the cabs cheaper than was originally expected. The cells are now charged at a central station; but as the service increases, charging stations in several parts of London will be required.

We learn from the *British Medical Journal* that a Bill has been introduced into the Legislature of Brazil offering a prize of 220,000 dollars (44,000*l.*), to be divided into two equal parts, which are to be awarded to the author of a work demonstrating the existence of a bacillus of yellow fever and the method of recognising it, and to the discoverer of an efficacious means of treating the disease. The Medical Institute of Rio Janeiro, the Hygienic Institute of Berlin, and the Pasteur Institute of Paris are to decide as to the award of the prizes. The Bill further provides for the reservation of a sum of 110,000 dollars (22,000*l.*) to be applied to the creation of an establishment for the preparation of a curative serum, the discoverer of which will be appointed organising director of the institute. The former of these prizes will probably be awarded to Dr. Sanarelli, an account of whose researches on the etiology of yellow fever was given in Nature of July 15 (p. 249). In the meantime, the Uruguay Legislature has conferred honorary citizenship on Dr. Sanarelli in recognition of his discovery of the microbe of yellow fever, and has voted him a grant of 10,000 dollars.

The view advanced by Gervais and Lucas, that the reproduction of *Scolopendra* is ovo-viviparous, has remained uncontradicted up to the present time. Signor Filippo Silvestri, writing in the *Atti dei Lincei*, now states that on July 3 of last year he discovered a specimen of *Scolopendra cingulata* carefully guarding its eggs under a stone, and in June of this year he has found several specimens with their eggs. It is thus proved that *S. cingulata* is truly oviparous. The centipede protects its eggs by covering them with its body, and does not abandon them unless violently molested. The ova are pale yellow and of ellipsoidal shape, measuring 3 mm. by 2·5 mm., and the statements of Gervais and Lucas were probably based on the observations of others, who were led to infer that the *Scolopendræ* were viviparous by the careful way these had concealed their ova.

The *Meteorologische Zeitschrift* for July contains an interesting article by Dr. J. Maurer, of Zürich, on the periodicity of cold and warm summers, based upon a discussion of the Berlin temperatures since 1728, and other trustworthy data. Among the most important papers bearing upon this subject in recent years, and to which due attention has been given in the present investigation, are (1) Köppen's eleven-year period of temperature; (2) Hellmann's uniformity of weather changes in successive seasons; (3) Lang's secular weather conditions as causes of glacier movements; and (4) Brückner's variations of climate since the year 1700. The author considers that the investigation decidedly shows that in the secular variations of

temperature the warm summers are often followed by the mildest winters, during the great periods of relative warmth, and that during the cold periods, the severest winters often occur after cool summers. As it seems probable that the same rule will hold good in the future, as obtained in the past, it may be expected that the next great period of relative warmth, which should begin about the end of the present century, will be marked by a series of warm summers, with occasional very mild winters, in Western Europe.

WE have received the *Sitzungberichte der K. Academie d. Wissenschaften* (Band. cv.), containing papers read before the Vienna Academy of Sciences in 1896. Among the numerous papers printed in the various parts into which the volume is divided, according to the sections before which they were read, we notice the following:—The secular acceleration of the moon, by the late Dr. E. v. Haerdtl: a discussion of observations of two large meteors seen on January 16 and 25, 1895, and an estimation of their paths, by Prof. G. v. Niessl; the influence of selective absorption on the extinction of light in the atmosphere, by Prof. J. v. Hepperger; the deflection of kathode rays, by G. Jaumann; the ultra-violet spark-spectra of metallic elements, by Prof. Franz Exner and E. Haschek. The results now described and illustrated by heliogravure reproductions of photographs are in continuation of those given in the preceding volume. The lines investigated are comprised between about $\lambda = 2200$ and $\lambda = 4600$. Further studies of projectiles, by Dr. Ludwig Mach. This paper is illustrated with several fine reproductions of photographs of moving bullets. On the indispensability of atomism in science, by Prof. Ludwig Boltzmann; magnetisation in two dimensions and hysteresis in a rotating field, by Prof. August Grau and Dr. Richard Hiecke; on the deviation of saturated water-vapour from the Marriott-Gay-Lussac law, by O. Tumlirz; on the effect of low temperatures (down to 0° C.) upon the transpiration of plants, by Hans. Molisch; on the scaling of the reproduced tail in lizards, by Dr. Franz Werner; geo-morphological observations in Norway, by Dr. Eduard Richter; morphological and biological investigations of lichens, by H. Zukal; physical-oceanic investigations in the Red Sea, by Prof. J. Luksch; remarks upon some problematic fossil structures, by Theodor Fuchs; new fossil plants in the Radoboj collection of the Liège University, by Prof. C. v. Ettingshausen; geological exploration of North Greece, by V. Hilber; zoological results of the expedition of the *Pola* to the northern part of the Red Sea, by Dr. F. Steindachner; on the blood corpuscles of vertebrates, by P. Knoll; the absorption of bacteria after local infection, by Dr. J. Halban; on the comparative anatomy of the larynx of mammals, by Dr. H. Albrecht; synthetic investigations of topaz, by A. Reich; on the occurrence of argon in the gases from a spring at Perchtoldsdorf, near Vienna, by Dr. Max Bamberger. Many other chemical papers (mostly organic) appear in Abtheilung ii.*b* of the volume just published.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mr. Samson Clark; a Laughing Kingfisher (*Dacela gigantea*) from Australia, presented by Mr. W. L. Chrystie; a Painted Terrapin (*Clemmys picta*) from North America, presented by Mr. C. R. Fisher; an Algerian Tortoise (*Testudo ibera*) from North Africa, presented by Captain A. Carpenter, R.N.; a Black-headed Lemur (*Lemur brunneus*, ♀) from Madagascar, two West African Love Birds (*Agapornis pullaria*) from West Africa, deposited; a Golden-crowned Conure (*Conurus aureus*) from South-east Brazil, purchased; a Yak (*Pœhagus grunnieus*, ♀), a Wapiti Deer (*Cervus canadensis*), two Saffron Finches (*Sycalis flaveola*), two Crested Pigeons (*Ocyphaps lophotes*), two Triangular Spotted Pigeons (*Columba guinea*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW SOUTHERN VARIABLES.—Dr. Gill records the discovery of four new variable stars by Mr. R. T. Innes at the Cape Observatory (*Astron. Nachr.*, No. 3441). The first three have a variation of about 1 magnitude, while the range of the fourth is as yet uncertain. Here are the facts:—

Star.	R.A. (1875·0) h. m. s.	Decl. (1875·0)	
C P.D. −32°·1376	7 4 46·4	−32 43·6	Mags. 9·0–9·7
Cord. LC. 8·679h.	8 8 16	−34 12·1	,, 6·8–7·8
Th. −27°·7724	10 45 22	−27 50·2	,, 8·7–9·9
Th −33°·8559	12 34 12	−33 53·1	Certainly changed 9·1–9·5

The second of the stars in the above list has a period of probably forty-five days.

COMET 1886 V.—Several provisional elements of this comet, which was discovered by Mr. W. R. Brooks, have been calculated, and all have led to the assumption of a parabolic orbit. Mademoiselle Klumpke has, however, undertaken a determination of the definite orbit, using all the available data, and publishes a preliminary result of this computation in the *Bulletin Astronomique* for August. She has found that after two trials a parabolic orbit is untenable, but in her third attempt an elliptic orbit with a period of less than 1000 years was more conformable with the data. The elements finally deduced, but still subject to slight modifications, owing to the discussion of 250 observations now in hand, are as follows:—

T = 1886 June 7, 391319, Paris M.T.

$$\left.\begin{array}{llll} \pi = & 33^\circ & 54' & 49''\cdot77 \\ \Omega & 192 & 37 & 27\cdot37 \\ i & 87 & 40 & 23\cdot67 \end{array}\right\} \text{M. Equin. } 1886\cdot0.$$

$$\begin{array}{ll} \log e & 9\cdot998572 \\ \log q & 9\cdot431056 \\ R. & 745 \text{ years.} \end{array}$$

Mademoiselle Klumpke mentions that in her computation she has met with numerous difficulties in consequence of the great inclination of the orbit, and of the large heliocentric movement, which reached 245°.

EFFECT OF PRESSURE ON SERIES IN SPECTRA.—Prof. J. S. Ames and Mr. W. J. Humphreys publish in the *Johns Hopkins University Circular* (No. 130) a brief account of the results of an investigation to find out the effect of pressure on the lines composing series in the spectra of certain elements. To this end photographs were taken of the arc spectra of all the elements which give series at both ordinary and increased pressures. Eye observations were also made. The results were as follows: The lines of any one series of a particular element are shifted alike, that is, according to the same law which is given as

$$\Delta\lambda = \lambda\beta\,(p_1 - p_0)$$

where λ represents the wave-length, $\Delta\lambda$ the shift produced by the increase of pressure $p_1 - p_0$, and β is a constant for any one series of a definite element. The constant β is different for the different series of the same element, the change being such that, very nearly, β for the principal series is one-half β for the first subordinate, and one-quarter that of the second subordinate. Further, the constant β is different for the same series of different elements, and one apparent regularity which demands attention is that, approximately, the value of β for similar elements (that is, zinc, cadmium, mercury) varies as the cube root of the atomic weight.

In the same journal Mr. Humphreys communicates another note on changes of wave-length due to pressure, which contains some new and interesting observations; and some of the relations which he has found to hold good, may be briefly referred to here.

The shift towards the red is directly proportional to the total pressure of the gas. This shift seems nearly or quite independent of temperature (cyanogen bands excepted). The shifts of similar lines of a given element are proportional to the wave-lengths of the lines themselves. Analogous or similar lines of elements belonging to the same half of a Mendelejeff group shift proportionately to the cube roots of their respective weights. The wave-lengths of those substances which, in the solid form, have the greatest coefficients of linear expansion, have the greatest shifts. Finally, the shift of similar lines is a periodic function of atomic weight, and consequently may be compared with any

other property of the elements which itself is a periodic function of their atomic weights.

We may mention that Mr. Humphreys has employed in this investigation several hundred photographs of almost every known metallic element at various pressures, and has carefully measured a large number of the lines of each.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE number of matriculated students attending German universities during the summer semester of this year is indicated by the first figures, the whole number of hearers by the second figures, and the number of women among the hearers by the third figures in the following list, which we reprint from the New York *Nation*: Berlin, 4705, 344, 114; Bonn, 1889, 103, 13; Breslau, 1541, 83, 22; Erlangen, 1140, 13; Freiburg, 1449, 95; Giessen, 663, 29; Göttingen, 1123, 72, 34; Greifswald, 834, 19; Halle, 1534, 101, 6; Heidelberg, 1230, 92; Jena, 704, 50; Kiel, 727, 37; Königsberg, 695, 31, 11; Leipzig, 3064, 157; Marburg, 1042, 48, 7; Munich, 3871, 160, 2; Academy of Münster, 487, 10; Rostock, 499, 10; Strassburg, 1016, 31; Tübingen, 1289, 12; Würzburg, 1430, 13. The whole number of matriculated students was 30,982, and hearers 1519, of whom 207 were women; students of theology 4326, of law 8368, medicine 8232, and philosophy 10,006. There was a marked decrease of students of theology and medicine, and an increase of students in the philosophical department, especially in philology and natural science.

THE current number (August 21) of the *Lancet* is devoted entirely to information of value to students who are about to commence the study of medicine. The numerous medical schools in the British Isles are described; and short articles are given upon the great continental schools which offer opportunities for post-graduate study. The regulations of the medical examining bodies in the United Kingdom, and some notes on the openings for medical men, show the students what they have to face before the goal of qualification is reached, and what prospects exist beyond. The advantages which a practical knowledge of photography afford practitioners is now generally recognised, and the *Lancet* is wise in advising medical students to become practical photographers. The student is enjoined to practise photography "because it tends to sharpen his powers of observation, to lead him to make faithful records, and to cultivate in him the artistic method. . . . At most medical schools now dark rooms are provided and other facilities afforded for taking photographs, since a knowledge of practical photography is found to be extremely useful in the dissecting room, in the post-mortem room, in the ward, and in the operating theatre, while the capacity to take a microphotograph is essential to the practical study of bacteriology and physiology."

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, August.—Fromondus and his notes on the weather. A recent number of *Ciel et Terre* gave extracts from these observations, made in 1614 and 1625, and the author (Prof. Monchamp) regarded the record as "the earliest kept in Belgium, if not in the world." Mr. Symons refers to the earlier records of Tycho Brahe, for 1582–97, and to Merle's observations, 1337–44, of which a facsimile copy was published in 1891.—Recent storm rains. Some remarkable rainfall records during thunderstorms in July last are quoted: On the 20th, at Oxford, 1·30 inch fell in an hour and a quarter; at Tottiford, in Devonshire, 2·75 inches fell in seventy minutes. On the 21st, 2 inches fell at Crouch End, between 2.0 and 5.0 p.m.; at Ipswich, 4·20 inches fell in one hour, and 5·02 inches in 2½ hours. On the 26th, at Southgate, Herts, 2·50 inches fell in less than an hour and a half.—Some old storms. These are accounts of remarkable thunderstorms in Suffolk, in 1557, and in Yorkshire, in 1741 and 1745.—Whirlwinds on June 30 and July 16. On the first date there was a storm of considerable fury in Birmingham, during which a shower of frogs fell in the suburb of Moseley, having evidently been absorbed in a small waterspout that passed over Birmingham during the passage of the storm.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 17.—"Studies in the Morphology of Spore-producing Members. Part III. Marattiaceæ." By F. O. Bower, Sc.D., F.R.S., Regius Professor of Botany in the University of Glasgow.

PARIS.

Academy of Sciences, August 16.—M. A. Chatin in the chair.—Observations of the periodic comet of D'Arrest made at the observatory of Toulouse, by M. F. Rossard.—Researches on simple kathode rays, by M. H. Deslandres. A continuation of the author's work on the kathode spectrum and kathode rays obtained by the use of the apparatus previously described.—Action of Röntgen tubes behind screens opaque to the X-rays, by M. Abel Buguet. Certain phenomena are described, and attributed to the diffusion of the X-rays in the air or other media, or possibly to the fluorescence produced therein.—The last stages of the development of the *Pedipalpi*, by Mlle. Sophie Pereyaslawzewa.—On the Pleistocene and recent deposits of the coast of Lower Normandy, by M. A. Bigot.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Bibliography of Science: W. S. Sonnenschein (Sonnenschein).—The A.B.C. of the X-Rays: W. H. Meadowcroft (Simpkin).—British Rainfall, 1896: G. J. Symons and H. S. Wallis (Stanford).—The "Opus Majus" of Roger Bacon: J. H. Bridges, 2 Vols. (Clarendon Press).—Volcanoes of North America: Prof. I. C. Russell (Macmillan).—Elements of the Comparative Anatomy of Vertebrates: Prof. R. Wiedersheim, adapted by Prof. W. N. Parker (Macmillan).—Citizen Bird: Scenes from Bird-Life in Plain English for Beginners: M. O. Wright and E. Coues (Macmillan).—The Principles of Fruit-growing: L. H. Bailey (Macmillan).—The Vivarium: Rev. G. C. Bateman (L. U. Gill).—Leçons sur L'Électricité: E. Gerard, cinquième édition, 2 Vols. (Paris, Gauthier-Villars).—Agricultural Statistics of British India for the Years 1891–92 to 1895–96 (Calcutta).—Fourteenth Annual Report of the Bureau of Ethnology, Parts 1 and 2 (Washington).

PAMPHLETS.—Microsismografi dell' Istituto di Fisica della R. Università di Padova: G. Pacher (Venezia, Ferrari).—Programm und Forschungsmethoden der Entwickelungsmechanik der Organismen: Prof. W. Roux (Leipzig, Engelmann).—Bromide Enlargements, and how to make them: J. Pike (Lund).—Bourne's Handy Assurance Manual, 1897 (E. Wilson).

SERIALS.—Quarterly Journal of Microscopical Science, August (Churchill).—American Journal of Psychology, Vol. viii. No. 4 (Worcester, Mass.)—Atlas der Himmelskunde: A. T. v. Schweiger-Lerchenfeld, Liefg. 1 to 8 (Wien, Hartleben).—Journal of the Asiatic Society of Bengal, Vol. lxv. Part 3, 1896; Ditto, Vol. lxvi. Part 2, No. 1, 1897 (Calcutta).—Proceedings of the Bath Natural History and Antiquarian Field Club. Vol. viii, No. 4 (Bath).—Bulletin of the American Mathematical Society, July (New York, Macmillan).—Proceedings of the Indiana Academy of Science, 1894–95 (Indianapolis).—Schriften der Naturforschenden Gesellschaft in Danzig, Neunter Band, Zweites Heft (Danzig).—Annals of the Astronomical Observatory of Harvard College, Vol. xxvi. Part 2 (Cambridge, Mass.).

CONTENTS.

THURSDAY, SEPTEMBER 2, 1897.

THE NECESSARY POSTULATES OF GEOMETRY.

An Essay on the Foundations of Geometry. By Bertrand A. W. Russell, M.A. Demy 8vo. Pp. xvi + 201. (Cambridge: at the University Press, 1897.)

THE title of this essay suggests a number of distinct problems. We may ask what the postulates of geometry are, or we may seek the source of our knowledge of them; in the latter inquiry, again, we may set out to discover how the fundamental geometrical notions grew up, or it may be our object to ascertain how we can have certainty concerning them. Mr. Russell's essay deals with the last of these questions. It is, on the one hand, a criticism of existing theories of geometry, and, on the other hand, it is constructive, and aims at formulating a new philosophical theory of the foundations of the science.

An abstract geometry, logically arranged, would start from a small number of definitions and postulates, and would proceed deductively. In the process there would occur places in the argument where a choice would be possible among different hypotheses, and at such places ambiguity would be removed by the introduction of fresh postulates. There would thus be different orders of postulates, some being required in order that there might be any geometry at all, and others being adapted to make geometry applicable to the formulation of experience. The problem of separating the postulates into such classes is the problem of transcendental geometry, or, as the author calls it, *Metageometry*.

Mr. Russell gives in his first chapter an outline of the history of metageometry. He shows how it began with attempts to deduce Euclid's parallel axiom from the remaining axioms, and how this attempt issued in the construction of logically consistent geometries which did not adopt the axiom; he describes how Riemann and Helmholtz attempted to classify geometrical axioms as successive determinations of space considered as a particular example of a more general class-conception—that of a manifold or numerical aggregate, and here he does not omit to summarise the extremely important results obtained by Lie in modifying and completing Helmholtz's investigation; lastly he explains how Cayley and Klein connected metageometry with projective geometry, and here he incidentally gives an account of what projective geometry is, and of its independence of the notion of measurement, a notion which was fundamental in Riemann and Helmholtz's methods. The chapter is partly historical and partly critical. It contains *inter alia* an answer to Cayley's challenge demanding that philosophy should either take account of the use of imaginaries in analytical geometry, or show that it has a right to disregard it (pp. 41–46).

The second chapter contains a criticism of philosophical theories of geometry propounded by Kant, Riemann, Helmholtz, Erdmann, Lotze, and others.

In the third chapter we have a discussion of the question what postulates are necessary in order that there may be a geometry at all. The same result is arrived at whether the subject is considered from the projective or the metrical point of view; it is that the necessary postulates are those of homogeneity, and continuity of space, and the existence of the straight line as a unique figure determined by two points. Thus the most general possible geometry includes Euclidean geometry, the hyperbolic geometry of Lobatschewsky, the spherical geometry of Riemann, and the elliptic geometry of Klein, but besides these there is no other. The postulates necessary to this general geometry are declared to be *à priori* axioms, while the parallel axiom and the axiom of three dimensions are found to be empirical.

The fourth chapter deals with some difficulties met with in the previous chapter, and traces some of the philosophical consequences of the theory proposed.

Mathematicians will turn with most interest to Chapter iii., to see what Mr. Russell lays down as the essential postulates of geometry, and how he establishes his conclusions. The chapter is divided into two sections, dealing respectively with the "Axioms of Projective Geometry," and the "Axioms of Metrical Geometry." In projective geometry, as the author points out, the notions of the point, straight line, and plane are presupposed. Technically, the subject starts from these notions, and determines by the methods of projection and section what figures are equivalent to a given figure. Philosophically, the subject has a wider aim, consisting in the determination of all figures which cannot be distinguished by their internal relations when quantity is excluded (p. 133). The kernel of the argument consists in the identification of projective equivalence with qualitative similarity. The author attempts to prove that a *form of externality* (a notion essential to the knowledge of a world of diverse and inter-related things) must possess precisely the properties attributed to space in projective geometry, these properties including homogeneity, and continuity, and the possibility of the straight line, or in other words of a unique figure determined by two points. He seeks, in fact, to deduce these properties of the form from the relativity of position. Without wishing to impugn the correctness of the deduction, or to deny the legitimacy of the conclusion, we cannot help thinking the argument obscure. This is especially the case in all that concerns the notion of the *point*. Thus, in speaking of the infinite divisibility of the form of externality (p. 138) he says:

> "The relation between any two things is infinitely divisible, and may be regarded, consequently, as made up of an infinite number of the would-be elements of our form, or again as the sum of two relations of externality."

He finds in the notion of the *point* "a self-contradictory result of hypostatizing the form of externality." This difficulty he recurs to again and again. Would it be presumptuous for a mere mathematician to suggest that this alleged contradiction may arise from the adoption of an antiquated mode of statement? We are told (p. 188) that the difficulty is extremely ancient. Is it not safe to say that the ancient philosophers had not firmly grasped and completely analysed the concept of the *mathematical continuum*? Mr. Russell says (p. 189):

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"Whatever can be divided, and has parts, possesses some thinghood, and must, therefore, contain two ultimate units, the whole namely, and the smallest element possessing thinghood."

The *mathematical continuum* contains no "smallest element," and there is, accordingly, no necessity for a thing which can be divided, and which has parts, to contain such an element. This remark may perhaps offer the key for the solution of the problem set by Mr. Russell, the problem namely of determining the properties of a *form of externality*. It is conceivable that, in arriving at the axioms of projective geometry as constituting a statement of these properties, he has assumed the solution of a problem in the *theory of manifolds* just as Helmholtz, in arriving at the axiom of constant *space-curvature* as necessary to congruence, assumed the solution of a problem in the *theory of groups*. In the latter case the weapon needed to attack the problem was forged at a much later date by Lie. In the case of Mr. Russell's problem the appropriate engine of discovery is still undeveloped, the mathematics of the manifold being at present limited to numerical aggregates. No one has yet done for the science of space what Dedekind did for the science of number.

Mr. Russell is happier in his treatment of the axioms of metrical geometry, and he has done real service to mathematics in pointing out the essential weakness of the Riemann-Helmholtz method. This method started from the consideration of space as a numerical aggregate, whose points are determined by coordinates, and then sought for the condition of the possibility of measurement. This condition was found in the uniformity of the measure of space-curvature, and it was shown, on the one hand, to imply the possibility of the straight line, and, on the other, to be equivalent to the statement that figures which can be brought to congruence are equal. The argument, as Mr. Russell shows, really involved a vicious circle. For space can be regarded as a numerical aggregate only if we have the means of assigning to points coordinates which have some spatial import, and coordinates which have such import presuppose measurement. The conclusion arrived at by Mr. Russell is that the essential postulate of metrical geometry is the *axiom of free mobility*, or the assertion of the possibility of equal figures in different places, and he has shown that the denial of this axiom would lead to logical and philosophical absurdities. In this connection it is only fair to Riemann to remember that his essay "Ueber die Hypothese, welche der Geometrie zu Grunde liegen" remained unpublished until after his death, a fact which points to the belief that he was not satisfied with it.

Leaving to philosophers by profession the task of appreciating and criticising Mr. Russell's philosophy of space, we may attempt to estimate the value of his book for mathematics. It has already been pointed out that in his criticism of Riemann and Helmholtz he has brought forward considerations which are mathematically important, and this is not the only place where he has had occasion to point to examples of the special philosophical vice of the mathematician, the tendency namely to mistake the sign for the thing signified (*cf.* Couturat "De l'Infini mathématique," p. 331). To mathematicians also his book should be interesting on account of its acute and novel treatment of familiar topics: thus—projective coordinates are numbers arbitrarily but systematically assigned to points of space "like the numbers of houses in a street" (p. 119). The ambiguity in the definition of distance, which is unavoidable on projective principles, does not show that distance is ambiguous, but that projective methods cannot adequately deal with distance (p. 35). The distinction between real and imaginary points is the distinction between quantities to which points correspond and quantities to which no points correspond (p. 44). The book is throughout well written, and is for the most part free from obscurity, and it may be recommended to all who wish to have clear ideas on matters of fundamental importance in mathematics.

A. E. H. L.

OUR BOOK SHELF.

A Bibliography of Gilbert White, the Natural Historian and Antiquarian of Selborne. Ey Edward A. Martin, F.G.S. Pp. xiii + 274. (Westminster: The Roxburghe Press, 1897.)

THERE are many places in England prettier than the little Hampshire village of Selborne, but none of them are so full of interest to the outdoor naturalist as the home of Gilbert White. Though more than a century has passed away since the simple student of nature's ways in the sleepy hollow of Selborne first gave the world the benefit of his observations and impressions, the book in which these notes are published is as fresh now as ever it was. The reason for this is, it seems to the writer, that Gilbert White was usually content to record facts as he found them, and he did not regard nature from the point of view of a pre-conceived theory. Accurate observations of natural objects and phenomena live for ever; but the explanation of such facts must alter from time to time as wider knowledge of the laws of nature is obtained.

The success of White's "Selborne" has had two unfortunate effects: it has made every country clergyman who can distinguish a martin from a swallow think that he is a Gilbert White, and it has caused the literary world to be deluged with so-called popular natural history works, which are often more remarkable for thoughts about nothing than for observations of something. We can, however, forgive the authors of such rhapsodies for inflicting their musings upon a busy world, because of the real naturalists which White's "Selborne" has created.

How large and widespread is the public to which the book appeals may be seen by the volume before us. Mr. Martin has found no less than seventy-three separate editions of our natural history classic; so the aggregate number of volumes published must be very great. The features of each of these editions are described in detail; hence Selbornites are now provided with interesting particulars of the various volumes which have refreshed the mind and administered to the intellectual enjoyment of thousands of nature-lovers the world over. Mr. Martin has not, however, confined his work to a mere list of editions of the "Natural History of Selborne"; he describes the naturalist himself and the main facts of his life, points out some of the chief observations and discoveries, gives a chapter on the village of Selborne, and devotes another to White's old house, "The Wakes." The work is thus more than a bibliography; it is a guide to the study of Gilbert White and his natural history, and as such will be prized by many of his disciples.

Reference is made on p. 71 to a suggestion of White's that entomology required some "neat plates" for its advancement, and it is stated that the idea has been carried out by the Science and Art Department. Surely there is a mistake here.

British Rainfall, 1896. By G. J. Symons, F.R.S., and H. Sowerby Wallis. Pp. 221. (London: Edward Stanford, 1897.)

MR. SYMONS has now 3219 observers who send him rainfall statistics from different parts of the British Isles. On the average, there is one rainfall station in every 21 square miles in England, one in every 36 square miles in Wales, one in 74 square miles in Scotland, and one in 179 square miles in Ireland. The task of editing the records obtained at all these stations is thus a heavy one, and it becomes heavier every year on account of the increase in the number of observers. Unfortunately, the tendency is for observers to increase in districts already adequately supplied with rainfall stations, and to decrease in districts where stations are badly needed. In Scotland and in Ireland there are areas of several hundred square miles without a single observer, and in the county of Sutherland, which contains over two thousand square miles, there are only six stations, three of which are so close together that they may be regarded as one. It is to be hoped that next year the editors of "British Rainfall" will be able to report that Sutherland is giving more assistance than it does now to a knowledge of the rainfall of the county.

In addition to the usual discussion of the rainfall and meteorological observations of 1896, and general tables of total rainfall, the present volume contains short articles upon the rainfall in the vicinity of Seathwaite—the most rainy part of England—evaporation experiments, the Heberden family and meteorology, and a comparison of German and English rain gauges and of Mr. Sidebottom's snow gauge.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The late Earthquake in India.

MR. R. D. OLDHAM, Director of the Geological Survey of India, has written to me for particulars of the photographic record of the Calcutta earthquake of June 12, 1897, as shown by the horizontal pendulum of this observatory. As Mr. Oldham is preparing a full report on this earthquake, he has also asked me to let it be known that he would esteem it a favour if copies of all records of its effects, wherever it has left any traces, be sent to him at the "Geological Survey Office, Calcutta." RALPH COPELAND.

Royal Observatory, Edinburgh, August 24.

On Mimicry.

IN a letter on p. 197 of NATURE, which I saw only a few days ago, Mr. Walter F. H. Blandford, referring to my suggestion as to the scarcity of individuals of mimetic species of Lepidoptera, rightly insists, that it has first to be shown that there is correlation between the acquirement of mimetic resemblance and the production of small numbers of specimens, before my suggestion becomes acceptable, and adds, that the advantage which the imago state of Lepidoptera probably derives from the resemblance to an immune model may possibly be counteracted by increased destruction in other stages. Mr. Blandford has apparently not taken into account what I thought to be too well known to need fuller explanation, and hence touched only by stating that "so many mimetic species are scarce, in comparison with the non-mimetic allies," namely, that the number of rare forms amongst mimics is remarkably greater in proportion than the number of rarities among their non-mimetic allies. This excess of scarcity among mimics Mr. Blandford's assumption of increasing destruction in the larval states does not meet, unless we assume, further, that only rare species can become mimetic, or that the excess of rarity among the forms which have become mimetic is due to the acquirement of mimetic resemblance, *i.e.* that there is the kind of correlation which my suggestion (p. 153) requires. In support of the latter alternative—the former does not concern us here—I adduce the following statements, at which I arrived by a comparison of the mimetic and non-mimetic forms of those two groups of Eastern Papilios among which mimicry occurs (Haase's subgenera *Cosmodesmus* and *Papilio, s. str.*).

(1) According to a rough estimate the proportion of the number of rare mimetic forms to the number of more common mimetic forms of Eastern Papilios is approximately as 1 : 2, while the proportion of the number of rare non-mimetic forms to the number of more common non-mimetic forms is as 1 : 4; that is to say, the number of rarities is among mimics about twice as large proportionally as among their non-mimetic allies. These numbers are, of course, not quite correct, as our knowledge of the insects in question is far from being complete. I add, incidentally, that the proportion of the rare to the common forms is as 1 : 2 in that group of Eastern Papilios which feed as larvæ on *Aristolochiaceæ*, and partly serve as "models."

(2) The mimetic species which are mimetic only in one sex, or resemble the model only superficially, are generally common.

(3) The mimetic species which are very variable are common, at least commoner than their less variable allies.

(4) The mimetic forms which agree very closely with the model in both sexes are the rarest (*cf.* Haase, "Mimicry," ii. p. 116: Stuttgart, 1893).

These four points are decidedly in favour not only of there being a connection between the acquirement of mimetic resemblance and the scarcity of individuals, but also of the excess of scarcity among the mimics being a consequence of the development of the mimetic characters. It does not seem to me to be far-fetched to say—as others have said before me—that rigorous adjustment of a species in one special direction (by Neo-Darwinian and Neo-Lamarckian factors) tends to lessen the adjustability of the species to changed conditions of life. The factor which has brought about mimetic resemblance is, according to the theory of mimicry, selection; as it was in my letter on p. 153 not my intention to bring forth new facts, but to show that one of the arguments against the theory of mimicry was invalid, I had to accept selection as *the* factor, and accordingly explained the excess of rarity amongst mimetic species by assuming that rigorous one-sided selection makes the species physiologically one-sided, *i.e.* less fit to meet new conditions of life equally well as the non-mimetic, more variable, allied species, the result of which would be proportionally greater scarcity of individuals or even extinction. KARL JORDAN.

Zoological Museum, Tring, August 25.

INTERNATIONAL CONGRESS FOR THE UNIFICATION OF METHODS OF TESTING.

IN 1884 the late Prof. Bauschinger, of Munich, conceived the idea of bringing professional men engaged in testing materials into personal contact, with a view to initiating researches into the physical and chemical behaviour of structural materials. Congresses were held at Munich, Dresden, Berlin, Vienna, and Zürich; and at the last-named Congress it was decided to form a permanent International Association, which now numbers 1200 members; and under its auspices the sixth International Congress was held at Stockholm on August 23, 24 and 25. Prof. Tetmajer, of Zürich, presided, and 452 delegates from all parts of the world were present. One member of each nationality represented was elected an honorary president, the complete list being as follows: Mr. Ast (Austria), Mr. Greiner (Belgium), Prof. Hannover (Denmark), Mr. Peters (Germany), Mr. Bennett Brough (Great Britain), Mr. Baucke (Holland), Mr. Banowitz (Hungary), Mr. Fadda (Italy), Mr. Krag (Norway), Prof. Belelubsky (Russia), Mr. Nyberg (Finland), Mr. Akerman (Sweden), Mr. Schraft (Switzerland), Colonel Mayandia (Spain), and Mr. C. G. Henning (United States).

The list of papers presented comprised an account of the development of the iron, brick and cement industries of Sweden, by Mr. A. Wahlberg; a description of micro-metallography considered as a method of testing, by Mr.

F. Osmond: a plea for uniform international specifications for iron and steel, by Mr. Ast and Mr. Barba; and an account of the advantages to be derived from the formation of an international laboratory for investigating the methods of analysing iron and steel, by Dr. H. Wedding. In the last-mentioned paper it was pointed out that the relations of buyers and sellers in the iron and steel trades would be put on a much safer basis if standard methods were worked out so that any chemist of ordinary skill could be trusted to carry them out. This could best be done at a central laboratory, where the work done in various countries could be collated and reduced to a common standard. A competent director for such a laboratory had been found in Baron Jüptner, and ample accommodation had been granted at Zürich by the Swiss Government. Subscriptions towards the cost of maintenance for ten years had been promised by some of the large British and continental ironworks, and it was consequently decided to begin operations in January next.

In addition to the discussions bearing upon the testing of iron and steel, several important memoirs were discussed in the Section, dealing with artificial building materials, the principal ones being on the relation between the chemical composition of natural building stones and their resistance to weathering, by Mr. A. Buess (Hamburg); on the testing of earthenware pipes, by Mr. Gary (Berlin); on the hardening process of calcareous cements, by Mr. D. W. Michaelis (Berlin); and on the determination of the quality of hydraulic cements, by Mr. M. Meyer (Malstatt).

The governing body, consisting of Prof. Tetmajer, Prof. Martens (Berlin), Prof. Debray (Paris), Mr. Berger (Vienna), and Prof. Belelubsky (St. Petersburg), was re-elected; and, in view of the fact that the whole of the Council of the Iron and Steel Institute had joined the Association, it was decided to have representatives of the English-speaking countries on the governing body, Mr. R. A. Hadfield (Sheffield) and Captain Carter (U.S. Army) being those chosen. It was further decided that in future the proceedings of the Congress will be published in English, as well as in French and German.

THE RADIATION OF LIGHT IN THE MAGNETIC FIELD.

DURING the past few months some interesting experiments have been made regarding the partial polarisation of radiations emitted by certain luminous sources when they are placed under the influence of a magnetic field. Important investigations in this direction have been made by Dr. Zeeman, of the University of Leyden, who has shown that the perturbations experienced by the ions, under the influence of magnetic forces, produced new periods of luminous vibrations. Continuing this work, Messrs. Egoroff and Georgiewsky (*Comptes rendus*, April 5, 1897), with the aid of a Rowland grating and a Ruhmkorff coil, have observed a feeble broadening of the lines D_1 and D_2 in the spectra of both axial and equatorial radiations. In investigating the appearance of coloured flames of polarised rays by using the Savart analyser, it was observed that the partial rectilinear polarisation of rays directed towards the equator of the magnetic field was easily observed, not only in flames of sodium, lithium and potassium, but in induction sparks between magnesium electrodes. In the cases of carbon, aluminium, mercury, zinc, bismuth and iron, the Savart analyser showed no indication of rectilinear polarisation. In a second communication to the same journal (*Comptes rendus* for May 3), the results there enumerated may be summed up as follows. The relative quantity of equatorial radiations emitted by a sodium flame, and polarised rectilinearly, varies with the intensity of the magnetic field according to a particular curve. Under the influence of a magnetic field of given intensity, the quantity of the light polarised rectilinearly, and emitted equatorially by the sodium flame, varies with the temperature of the flame. In studying the change of spectra of metals in a field of considerable intensity, a modification of the method of procedure was adopted, and resulted in the discovery of the rectilinear polarisation of the equatorial radiations. Nearly all the metals employed—namely, Cu, Tl, Zn, Cd, In, Mg, Ca, Ba, &c.—showed polarisation exclusively for those rays that are easily reversed. The phenomenon, the authors state, "is observed in a very instructive manner for the copper in the green part of the spectrum (the change is very large for the ray 5105, most feeble for 5153, and zero for the long waves 5217 to 5292). For indium, the change only occurred for the violet ray at 4510, while the others (6193, 5230, 5900, 4680, 4616 and 4638) were not influenced by the field at all." In experiments with Geissler tubes containing hydrogen and helium, no definite results up to the present have been obtained.

In the experiments just referred to, it may be mentioned that all the observations were made with the eye. It would, however, be interesting to inquire whether the photographic plate would register these small variations, for then we should have a permanent record of a phenomenon which is not so very easy to observe, or which, at any rate, might be subject to "personal" error. The application of photography to show such effects has been accomplished by Mr. Alexander Anderson, assisted by Mr. Adeney. They employed a Rowland grating of 21·5 feet radius, and obtained photographs of the cadmium spectrum, the source of light being a spark between cadmium electrodes from the secondary of a large induction coil. Mr. Anderson's account of his experiments is briefly summarised as follows.

"Three lines are very distinct in all the photographs, namely, those of wave-lengths 5086, 4800, and 4678 tenth-metres. Photographs were taken, both without and with a magnetic field, the time of exposure being exactly the same in both cases. This field was produced by a large electro-magnet excited directly by a dynamo giving a pressure with open circuit of 70 volts, the flat poles of the electro-magnet being covered with ebonite, so that they could be brought very close to the cadmium electrodes without interfering with the sparking. The field thus produced was practically uniform, and its intensity was found to be about 17,000 C.G.S. units."

In the first photographs the slit width was about ·001 cm., but in the later photographs about twice this width was used. An examination of the photographs showed that there was no evidence of any effect of the magnetic field, though the definition of the lines was all that could be desired, namely, very clear and sharply defined. When it be remembered "that a length of one centimetre in the photograph corresponds to a change of wave-length of 26 tenth-metres, and since an increase of breadth of a line of one-tenth of a millimetre (and probably much less than this) could easily be seen on the photographs, there could not have been a change in the period of oscillation of as much as one part in 20,000."

To account for this negative result, Mr. Anderson suggests two possible reasons: viz. that perhaps the magnetic field was not of sufficient intensity, or that the exposure (thirty minutes for the narrow slit) was not long enough. He states, however, that with an eyepiece in place of the camera, he "saw (or fancied he saw) a widening of the lines."

The whole phenomenon of the widening of the lines in the spectra of metallic substances in a magnetic field is, however, of great interest to both physicists and astro-physicists, and it is important that both eye and photographic results should be obtained when possible.

SAMUEL EDWARD PEAL.

SAMUEL EDWARD PEAL, who died at Moran, Sibsagur, Assam, on July 29, was born December 31, 1834. Originally an artist, he went to India in 1862 as a tea planter, and it was while so engaged in 1873 that he discovered that the tea blight was due to the ravages of a kind of Aphis, "the tea bug of Assam," since named the *Helopelta theovora*, the life-history of which he worked out with suggestions for its extermination.

He was a Fellow of the Royal Geographical Society and of other Societies, and did good service in exploration among the Naga Hills, mainly with a view of showing the practicability of a direct route from India to China (the old Burmese route) over the Patkoi range, a work much appreciated by the Indian Government.

As a philologist his acquaintance with the various dialects of the hill men, and his great tact in dealing with them, made his presence acceptable where others had failed.

He devoted many years to the study of the grasses and trees of Assam and their life-histories, and had completed and profusely illustrated his work upon them, when the bungalow (during his absence) was destroyed by fire with all its contents, and his many years of labour wasted.

Astronomy of late years occupied his attention, and his theory of lunar surfacing as due to glaciation is gradually becoming accepted. He also wrote a paper "On a Possible Cause of Lunar Libration, &c." He was a frequent contributor to the Indian press, and also to the columns of NATURE, on various natural history subjects, and had recently traced the connection between the Dyaks of Borneo and some aboriginals of Assam. Having resided thirty-five years in Assam, he was considered the *doyen* of the Europeans of the province, and being held in high esteem, his loss will be severely felt.

NOTES.

THE concluding general meeting of the British Association at Toronto was held on Wednesday, August 25. Special thanks were accorded to Prof. Macallum, the leading local secretary, for the active share he had taken in making the meeting such a very successful one. The total attendance at the meeting was announced as 1362. The *Times* correspondent reports the following facts of interest:—Among the important new grants are 50*l.* towards the Meteorological Observatory in Montreal, 75*l.* for the biology of the lakes of Ontario, 125*l.* for the anthropology and natural history of Torres Straits, 100*l.* for the investigation of changes associated with the activity of nerve cells—total grants, 1350*l.* A new committee of great importance has been appointed. The Council was requested to consider the desirability of approaching the Government with a view to the establishment in Great Britain of experimental agricultural stations similar in character to those which are producing such satisfactory results in Canada. The committee is to report on the means by which in various countries agriculture is advanced by research, by special educational institutions, and by the dissemination of information and advice among agriculturists. The Association is to meet in Bristol next year, and in Dover in 1899.

THE Chancellor of the Exchequer has informed the executors of the late Sir Wollaston Franks that he will remit the estate duty on the bequest to the British Museum of the valuable collections and books which he left to it on that condition (see p. 275). The collection has therefore now been handed over.

IT is reported that the Duke of the Abruzzi (Prince Luigi of Savoy) and his party reached the summit of Mount St. Elias, at an altitude of 19,000 feet, on July 31. The expedition, which was the most successful that has ever undertaken the ascent of Mount St. Elias, passed fifty-one days on the ice and snow. It is stated that the explorers declare that they did not see the slightest indication that Mount St. Elias had been volcanic.

THE Committee on Indexing Chemical Literature presented its fifteenth annual report to the American Association for the Advancement of Science at the recent meeting. From the report we learn that a bibliography of the metals of the platinum group, 1748–1896, by Prof. James Lewis Howe, and a review and bibliography of metallic carbides, by Mr. J. A. Mathews, have been completed, and have been recommended to the Smithsonian Institution for publication. A bibliography of basic slags, technical, analytical and agricultural, has been completed by Karl T. McElroy. The channel of publication has not been determined. The second edition of the catalogue of scientific and technical periodicals, 1665–1895, by Dr. H. Carrington Bolton, is entirely printed, but has not yet been published. The new edition contains 8603 titles. A supplement to the select bibliography of chemistry, 1492–1896, has also been completed by Dr. Bolton, who has presented the MS. to the Smithsonian Institution. This supplement contains about 9000 titles, including many chemical dissertations, and is brought down to the end of the year 1896. Progress is also being made with an index to the literature of thorium; an index to the literature of tantalum; a bibliography of oxygen; and a bibliography of the constitution of morphine and related alkaloids. Letters for the Committee should be addressed to the Chairman, Dr. H. Carrington Bolton, at Cosmos Club, Washington, D.C.

MORE than seven thousand members attended the twelfth International Medical Congress held at Moscow on August 19–26. From a report in the *Lancet*, we learn that the Grand Duke Sergé Alexandrovitch officially opened the Congress on August 19, in the presence of a brilliant assembly; Count Delianof then delivered a short address of welcome in the Latin tongue. Prof. Sklifosovski, president of the organising committee, also delivered an address. Prof. Roth, the general secretary, then gave an account of the preliminary labours of the organising and executive committees. The recent Congress was larger than any of its predecessors, the number of members exceeding 7300, more than half of whom came from abroad. Prince Galitzin, the Mayor of Moscow, welcomed the members of the Congress in the name of the city of Moscow, and added that to commemorate the event the municipality had decided to offer a triennial prize for the best work on some selected medical subject. After brief addresses by the delegates of the different countries represented at the Congress, Prof. Virchow gave an address upon "The Continuity of Life as the Basis of Biological Science." The second address was by Prof. Lannelongue, who had for his subject "The Surgical Treatment of Tuberculosis." Dr. Lauder Brunton then read an address on "The Relations between Physiology, Pharmacology, Pathology, and Practical Medicine." This address is printed in the current number of the *Lancet* (August 28).

THE sixty-fifth annual meeting of the British Medical Association was opened at Montreal on Tuesday. This is the first occasion on which the Association has met outside the British Isles. About two thousand delegates from all parts of the British Empire are attending the meeting. The French Government sent Dr. Charles Richet as its official representative, and about four hundred leading American physicians are present. The opening meeting took place on Tuesday afternoon. The Mayor of Montreal welcomed the Association on behalf of the city; while Sir A. Chapleau, French-Canadian Lieutenant-Governor, and Lord Aberdeen, expressed the welcome of the province and the Dominion respectively. Dr. T. G. Roddick, Professor of Surgery in the McGill University, and president of the Association, then delivered an address on the objects of the

Association, Canadian climatology, and the state of medical education in Canada. A vote of thanks for the address was proposed by Lord Lister, and seconded by Sir James Grant. Upon the evening of Tuesday Prof. Richet delivered a lecture upon Pasteur and his work.

THE annual general meeting of the Federated Institution of Mining Engineers will be held in Edinburgh on September 14–16. The following papers are among those to be read or taken as read:—"Submarine Coal-mining at Bridgeness," by Mr. Henry M. Cadell. "Alternating Multiphase Machinery for Electric-power Transmission," by Mr. Walter Dixon. "Observations on some Gold-bearing Veins on the Coolgardie, Yilgarn, and Murchison Gold-fields, Western Australia," by Mr. Edward Halse. "The South Rand Coal-field and its connection with the Witwatersrand Banket Formation," by Mr. A. R. Sawyer.

IN the *Atti dei Lincei*, vi. 2 (July 18), Dr. Calandruccio and Signor Grassi give a brief account of their latest observations on the metamorphoses of the Murienoids. The authors have followed the transformation into the cæcal stage of several *Leptocephalus brevirostris* having their larval teeth still intact. This transformation takes place without the animal burying itself in sand. It is noteworthy, too, that the anterior and posterior extremities of the body have already acquired nearly all the characteristics of the cæcal stage when the remainder of the body is still far from possessing them. The Leptocephaloids of *Myrus vulgaris* are very similar to those of *Ophichthys hispanus* (= *O. remicaudus*). The Tiluroids may in all probability be referred to *Serrivomer*. Dr. Calandruccio and Signor Grassi have now observed the larval and semi-larval stages of all the Murenoids of the Mediterranean, with the exception of the very rare *Chiopsis bicolor* and the occasional *Murænesox savanna*.

A METHOD of determining the heights of clouds, and especially of the ill-defined stratus cloud, by means of the search light, was suggested by Prof. Cleveland Abbe many years ago. It was proposed to establish a search light, the beams of which should be vertical; the apparent altitude of the centre of the luminous spot of the cloud was to be observed from a station not far away, and the height was a matter of easy calculation. Prof. Abbe returns to the subject in the *Monthly Weather Review* (May), and points out that with the great increase in the power of the modern search light, further applications have become practicable; thus in harbours on the sea-coast, where one wishes to ascertain the presence and development of low-lying fogs, the search light which renders them visible is an invaluable assistant. A year ago some accounts were published relative to the cloud effects on Mount Low and Pasadena. According to these accounts Mount Low is about 15 miles north-north-east from Los Angeles, and about 6 miles in a straight line from Pasadena. When the beam of light fell upon the bodies of clouds they at once became luminous, so that all the details of motion were visible; when the beam fell upon the falling rain, the great cone of light glowed like molten metal. It seems, concludes Prof. Abbe, that the formation and motion of fog and cloud at night-time could be advantageously studied by means of the search light. The height at which fog first forms, and its gradual extension upwards and downwards during the night, would be a very interesting and profitable investigation.

THE disturbance of submarine cable working by electric tramways forms the subject of a paper by Mr. A. P. Trotter in the *Journal* of the Institution of Electrical Engineers. As soon as the electric tramway service was started at Cape Town, the working of the syphon recorder of the submarine cable of the Eastern and South African Telegraph Company was found to be seriously affected. When the tramcars were started and when they were stopped, "kicks" were recorded by the syphon recorder, and these being superimposed upon the received signals made it difficult and often impossible to read the message. The first mile of the cable was at a mean distance of about half a mile from the tramway. After a long series of experiments Mr. Trotter found that the only way to cancel the disturbances was to lay a new cable of about five miles long as nearly as possible over the old one, the cable terminating in an earth plate. As soon as this had been done the traffic was resumed, and no appreciable disturbances of the recorder took place. In the discussion upon the paper, Mr. W. H. Preece said that similar disturbances occurred wherever electrical tramways, and telegraphs, submarine or overland, existed together. Prof. Ayrton gave an account of observations of magnetic disturbances over the whole neighbourhood of the City and South London Electric Railway, which runs underground between London Bridge and Stockwell. The suspended magnet used in the investigation showed that disturbances of the earth's magnetic field occurred throughout the whole region of the line, and were caused either by magnets or masses of iron in the passing trains, or by currents passing through the earth.

AMONG many other papers in the *Proceedings* of the Indiana Academy of Science, dated 1894, but only just received, is one by Mr. D. T. MacDougal, showing that various species of Cypripedium have an irritant action upon the human skin. It was found that when the leaves of *C. spectabile* were rubbed lightly upon the skin of the wrist, arm, face, or ear, the person experimented upon was usually "poisoned" in a degree corresponding to the manner of application, and in a time varying from ten to twelve hours. There could be no doubt about the unpleasant effects produced by the leaves, for Mr. MacDougal soon found that he could not obtain subjects willing to sacrifice their feelings upon the altar of scientific knowledge. He was able to prove, however, that similar painful effects were produced by *C. pubiscens* and *C. parviflorum*. To ascertain whether the effect was due to the mechanical injury resulting from piercing the skin by the pointed hairs upon the leaves, or to the corrosive action of the secretion found on the outside of the globular tips of the glandular hairs, separate tests were made by material from *C. spectabile*. The hairs of each kind were taken from the leaf by means of a pair of fine forceps, and the tip pressed against the skin. Irritation was found to result from the contact of the glandular hair only. It was found, further, that the irritant action of the plant increased with the development of the plant, and reached its maximum with the formation of the seed-pod, from which it is inferred that this is a device for the protection of the reproductive bodies during the period from pollination to the maturity of the seeds.

THE *Sitzungsberichte der Physikalisch-medicineschen Societät in Erlangen* for 1896 contains a paper, by M. Willibald Hoffmann, on the forces exerted by an electric field on an incandescent electric lamp, through which a current is flowing. When a highly exhausted vacuum tube is placed in the neighbourhood of such a lamp, it is found that, with discharges of moderate frequency, the filament begins to oscillate; more rapid discharges, however, impart to the filament a certain rigidity of position, which causes it to tend to maintain a fixed distance from the discharge-tube when the lamp is moved about. The author investigates the cause of these phenomena.—The same volume contains papers by Alfred Bettinghaus, on the geology of the Rathsberg plateau; by Dr. Gotthold Fuchs, on certain aniline derivatives and their physiological action; by Dr. Fritz Glatzel, on the alkalimetry of the blood; and by Dr. Joseph Rosenthal, on Röntgen rays.

THOSE interested in the properties of kathodic and allied rays, will find quite a series of papers in the last five numbers of the *Atti della R. Accademia dei Lincei*. Among these we would call especial attention to the following:—On the action of electricity on the discharging property induced in air by x-rays, by Prof. E. Villari (vol. vi. part 1, p. 343).—On the penetrating power of the same rays, by A. Ròiti (*ibid.* p. 354).—On electric discharge in gases, and on certain phenomena of electrolysis, by Vito Volterra (*ibid.* p. 389), dealing with phenomena allied to those observed by Sella and Majorana, in connection with the action of Röntgen and ultra-violet rays on the electric spark.—On the electrostatic charges generated by kathodic rays, by Q. Majorana (vol. vi. part 2, p. 16), who finds that the emanation of kathodic rays depends to a certain extent on the position of the anode.—On the discharging action of air after being traversed by x-rays, by Dr. Adolfo Campetti (*ibid.* p. 43), who considers that the so-called effects of dispersion by air, modified either by x-rays or by combustion, depends on a temporary increase in the conductivity of the gas.—On the non-penetration of electric waves into the space enclosed by a metallic shell, by Prof. Augusto Righi (*ibid.* p. 59).—On the velocity of kathodic rays, by Q. Majorana (*ibid.* p. 66), who obtains values for the velocity ranging from 100 to 600 kilometres per second.—On the double refraction of wood for electro-magnetic waves, by Prof. Domenico Mazzotto (*ibid.* p. 73), who finds (*a*) that the index of refraction varies considerably in different woods, and increases with the density; (*b*) that in the same wood electric oscillations perpendicular to the fibres are propagated more rapidly than those parallel to the fibres, and, hence, the index of refraction is less for the former; (*c*) that the difference between the two indices is less for dense than for light woods.

THE action of light on various kinds of yeasts has lately been elaborately investigated by W. Lohmann. Kry has shown that the division of the cell in the case of *Sacch. cerevisiæ* takes place as vigorously in the presence of moderate light as in the dark, but the action of intense light upon this and other varieties of yeast has been studied by Lohmann. Exposure to the electric light, 11,590 candle-power, was found to exert a distinctly retarding action on the multiplication of these yeast cells. The sun's rays were, however, much more detrimental to their vitality, for after several hours' direct and uninterrupted insolation in the months of May and June, the rise in temperature being prevented by immersion of the agar-dishes containing the yeast cells in water, the latter were entirely destroyed. On the other hand, yeast cells kept in the dark during the same period of time, or only exposed intermittently to feeble sunshine, exhibited distinct multiplication. A microscopic examination revealed also a striking morphological difference between the cells kept in the dark and those which had been insolated. Whereas the former presented a perfectly normal appearance, the latter looked shrunken, exhibited irregular contours, and the plasma was drawn together in lumps, chiefly in the direction of the poles of the cells. Similar insolation experiments on other varieties of yeast exhibited the same lethal effect produced on these organisms by prolonged exposure to direct sunshine.

A NEW edition (the fourth) of Mr. Howard Collins' "Epitome of the Synthetic Philosophy of Herbert Spencer" (Williams and Norgate) has just been published. Mr. Spencer contributes a brief introduction to the volume, which is now a representation in miniature (if the word can be applied to a volume of nearly seven hundred pages) of the whole of his philosophy.—Dr. Max Verworn's "Allgemeine Physiologie" (Jena: Gustav Fischer), the first edition of which appeared early in 1895, has reached a second edition. Shortly after the original work appeared, its scope and many valuable qualities were described in these columns (vol li. p. 529). The volume has been thoroughly revised, and will doubtless pass through many more editions. English and Italian translations are being prepared. A Russian edition appeared some time ago, but Dr. Verworn states that it was published without his authority.

THE following are among the articles and other publications which have come under our notice within the past few days:—"On the Development and Structure of Dental Enamel," by Dr. J. Leon Williams, in the *Journal* of the Royal Microscopical Society (August). The paper is illustrated with several excellent photo-micrographs showing various phases of enamel development.—The Chemical Society has just issued the annual supplementary number of its *Journal*, containing title-pages, contents, and indexes of volumes lxix. and lxx. (1896). To chemists this record of contributions to chemistry must be invaluable.—Following other scientific instrument-makers, Messrs. Howard B. Little and Co. have prepared and issued an illustrated list of apparatus and accessories for work with Röntgen rays. Persons who require an efficient outfit at a reasonable price should see Messrs. Little's list.—A description of the various forms of Australian bullroarers, accompanied by illustrative drawings, is contributed to the *Journal* of the Anthropological Institute (August), by Mr. R. H. Mathews. The same publication contains papers on the Berbers of Morocco, by Mr. W. B. Harris; Káfiristan and its people, by Sir George Scott Robertson; and further discoveries of ancient stone implements in Somaliland, by Mr. H. W. Seton-Karr.—In the *Journal* of the Royal Horticultural Society (August) are papers on the study of microscopic organisms, and its importance to horticulturists, farmers, and foresters, by Prof. Marshall Ward, F.R.S.; diseases of plants, by Mr. George Massee; and the physiology of pitcher-plants, by Prof. Sydney H. Vines, F.R.S.—Dr. C. M. Aikman has sent us a pamphlet on "Sixty Years of Agricultural Science," reprinted from the *Agricultural Gazette*.—*The Quarterly Journal* of the Royal Meteorological Society (July), just issued, contains a report of a lecture by Mr. G. J. Symons, F.R.S., on "Meteorological Instruments in 1837 and in 1897," with plates illustrating the types of instruments employed sixty years ago and now in meteorological observations.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*) from South-east Africa, presented by Mrs. Charlesworth; five Australian Bush Rats (*Mus arboricola*) from New South Wales, presented by Mr. Edgar R. Waite; two Egyptian Kites (*Milvus ægyptius*) from South Africa, presented by Mr. G. A. Ogilvie; a Mountain Ka-Ka (*Nestor notabilis*) from New Zealand, presented by Mr. Arthur Hope; two Ravens (*Corvus corax*), British, presented by Mr. W. B. Bingham; a Turtle Dove (*Turtur communis*), British, presented by Miss Mallard; a Purple Sunbird (*Cinnyris asiaticus*) from India, presented by Mr. Frank Finn; a Tawny Owl (*Syrnium aluco*), British, presented by Mr. C. Hastings Bostock; two Ring-necked Parrakeets (*Palæornis torquatus*) from India, presented by Miss M. Parsons; a European Pond Tortoise (*Emys orbicularis*), European, presented by Mr. F. E. Bastian; a Goliath Beetle (*Goliathus druryi*) from the Gold Coast, presented by Mr. W. Durham Hall; a —— Spider (*Mygale*, sp. inc.) from South Africa, presented by Mr. Rowland Ward; a Feline Genet (*Genetta felina*), a Delalande's Lizard (*Nucos delalandii*), a Puff Adder (*Bitis arietans*), a Cape Bucephalus (*Dispholidus typus*), a Rough-keeled Snake (*Dasypeltis scabra*), two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), an Infernal Snake (*Boodon infernalis*), two Lineated Snakes (*Boodon lineatus*), a Rufescent

Snake (*Leptodira hotambaia*), three Crossed Snakes (*Psammophis crucifer*) from Port Elizabeth, South Africa, presented by Mr. J. E. Matcham; a Brown Capuchin (*Cebus fatuellus*) from Guiana, deposited; a Rough Fox (*Canis rudis*) from Guiana, two Black-throated Weaver Birds (*Ploceus atrigularis*), two Bengal Weaver Birds (*Ploceus bengalensis*) from India, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

RELATIONSHIP BETWEEN THE MASSES AND DISTANCES OF THE PLANETS.—In a previous number of NATURE (vol. lv. No. 1433) Mr. G. E. Sutcliffe, writing from Bombay, suggested a relationship between the masses and distances of the four superior planets. He found that when the masses and distance of each of the planets were multiplied together, the resulting numbers formed a series in geometrical progression having a common ratio of 1·8391, this latter number being nearly equal to the mean distance of Saturn (1·8338) when the mean distance of Jupiter is taken as unity. In a recent communication to us he has worked out the case of the inferior planets, with the result that the relationship of these planets to one another is not the same as obtained in the previous investigation. The ratios are still, however, in powers of the same value of R (the common ratio), namely 1·8391; and for this reason Mr. Sutcliffe suggests that this number is perhaps one of the constants of the solar system. In the same communication he gives a formula which expresses the mass of the sun in terms of the masses and distances of Venus, the earth and the moon, and from this he investigates the question of whether there is a planet which bears the same relationship to Jupiter that the earth and moon do to Venus. The mass, distance, and period of this hypothetical planet are given, but we doubt considerably its actual existence.

THE MADRAS OBSERVATORY.—Mr. C. Michie-Smith, the Government astronomer at Madras, tells us in his report for the year ending March 31, that, as regards the staff, the Government has sanctioned the revival of the appointment of a chief assistant. The past year has been conspicuous by the great amount of heavy rain, and both the director's and assistants' houses have suffered considerably. Observations for time have, as usual, been carried on, and the investigation for the determination of the divisions error of the Meridian Circle has been completed, no less than 72,192 micrometer readings being employed. The Madras Catalogue has further advanced, and the mean places for the first sixteen hours have been deduced. Proposals have been sanctioned for observing the total eclipse of the sun next January, and Karad has been fixed upon as the most suitable station.

STATIONS FOR OBSERVING THE TOTAL ECLIPSE OF THE SUN IN JANUARY 1898.

THE land path of the line of the total eclipse of the sun commences from a little south of Ratnagiri, on the Bombay coast, and runs in a north-easterly direction to Nepal, passing nearly over Mount Everest, and then disappears in Thibet. The shadow of the moon will therefore pass through parts of the Bombay Presidency, through Hyderabad, Berars, Central Provinces, and parts of Central India, Bengal, and North-west Provinces. The length of the path through India is about a thousand miles, and the width of the shadow roughly fifty miles. Hence the area from which observations *could* be taken is enormous. In India, however, facilities for travelling simply do not exist at all over by far the greater part of the country; and as accommodation for European travellers is even more scanty than the means of transport, the number of stations from which observations of the forthcoming eclipse are likely to be made is much smaller than would be expected. As the duration of the total phase of the eclipse on the central line decreases from about two minutes ten seconds on the Bombay coast, to about one minute forty seconds in parts of Bengal and the North-west Provinces, the natural tendency will be for observers to prefer the western stations. In addition, too, it would appear that the meteorological conditions are more favourable at the western than at the eastern or central stations on the line of totality.

The majority of travellers visiting India for the purpose of observing or seeing the total eclipse will land either at Bombay or Calcutta, probably at the former station. From Bombay several parts of the line of totality can be comfortably visited. The stations on the Bombay coast can be very easily reached by the local steamers of the Bombay Steam Navigation Company. As at present arranged, there is a daily passenger steamer to and from Bombay, calling at such ports as Ratnagiri and Viziadurg, which are close to the central line, and at Jaygad, which is close to the north limit of the line of totality, and at Dewgad, which if just within the southern limit. Combined passenger and cargo steamers also leave Bombay for some of these ports twice or three times weekly. The journey only takes from twelve to eighteen hours each way. The fares are cheap, the first-class fare from Bombay to Ratnagiri being seven rupees; the second, two rupees; and the third, one rupee four annas. It should be remembered that these fares do not include food; also that the steamers are small, even the combined passenger and cargo steamers having only about five cabins. Hence passengers should take their own bedding and food, and, for comfort's sake, should travel with their own servants.

Several other points on the line of totality can be reached by the railway from Bombay. Commencing with the lines of communication from the west side of India, the train can be taken *viâ* Kalyan Junction to Poona, passing through the Ghats. From Poona two lines diverge, one to Satara, which is a little north of the central line of totality and well within the northern limit, and from thence to Koregaon, &c., while the second line passes through Sholapur to Hyderabad, &c.; but on this second line there are no considerable stations within the line of totality, nor are there any towns within reasonable distance of the railway, though the smaller stations of Indapur and Kumbhargaon may be easily reached.

Another section of the line of totality can be visited from Bombay by the Great Indian Peninsular Railway *viâ* Kalyan Junction to Bhusawal Junction, proceeding thence to Amraoti, Pulgaon, Warda, and Nagpore. Pulgaon and Nagpore are said to be good stations for the purpose of observation. It should also be stated that Nagpore can be easily reached from Calcutta by the East Indian and Bengal Nagpore lines of railway, the latter railway being joined at Assensole Junction on the East Indian Railway.

Another section of the line of totality can be reached by continuing the journey by the Great Indian Peninsular Railway from Bhusawal Junction to Jubbalpore, where the East Indian Railway is joined, and then passing southwards from Katni by the Bilaspur branch. Again, this railway line crosses the path of the moon's shadow at a point where there are no towns of any importance.

The other parts of the line of totality which are crossed by the lines of railway could be reached either from Bombay by continuing the journey from Bombay to Allahabad, and then turning southwards on the East Indian main line, or more easily by making Calcutta the starting point, and proceeding northwards from there. The main line of the East Indian Railway crosses the line of totality from a little south of Benares to a little north of Arrah, the considerable station of Buxar being almost on the central line. There is also a small branch line leading to Ghazipur, which is said to be a good place for observations, and is also a fair-sized station. Again, leaving the East Indian Railway at Bankipore by means of the Bengal and North-western Railway, the path of the shadow can be easily visited, the considerable station of Chupra being near the southern limit. Again, by leaving the East Indian Railway at Mokameh, two sections of the shadow path can be reached by the Bengal and North-western and Tirhoot Railway, and the most considerable station on these two lines is Motiharee.

There are, therefore, eight sections of the path of the eclipse which are cut by various railways, in addition to the coast line which can be reached by the line of steamers: so that nine sections, or stations on the central line, could be easily occupied if necessary.

A considerable amount of local information as to sites suitable for observing parties has been collected by a committee of the Asiatic Society of Bengal at Calcutta,[1] and in connection with

[1] Copies of the information collected could probably be obtained by application to the Honorary Secretary, Bengal Asiatic Society, 57 Park Street, Calcutta.

the inquiries made, the various railway companies on which observing parties would have to travel have very liberally promised to make considerable reductions from their usual rates of fares, and for carriage of luggage, instruments, camp furniture, &c., to all *bonâ fide* observers and observing parties. Thus the Southern Mahratta Railway, running in the West of India, offer to give free passes to all observers; the Great Indian Peninsular Railway will allow all parties of observers to travel at half rates on ordinary trains; and the East Indian, Bengal and North-western and Bengal Nagpore Railways will make a reduction of 25 per cent. from their fares, &c., to observers and observing parties.

It must not, however, be thought that the conditions in India for parties travelling are the same as in England or Europe generally. Food can be had at the various refreshment rooms on all the main lines of railway, but on the branch lines the passenger has frequently to carry his own food. Again, all first and second class passengers travelling at night in Indian railways are entitled to a sleeping berth without extra charge; but each passenger must provide his own pillows, rugs, &c., if he wishes to be comfortable.

Again, in the matter of accommodation for visitors, conditions in Indian towns and villages are very different from those in Europe. At such towns as Calcutta, Bombay and Benares hotel accommodation is fairly plentiful; but even here at certain seasons of the year the demand is larger than the supply, and rooms should be engaged beforehand.

Except at such large towns as those mentioned, or at places on the usual route of tourists, hotels are not to be found, and in the great majority of cases travellers in India have to make their own arrangements for living and accommodation. At the headquarters stations in the various districts into which India is divided, it is true that Government keeps up small houses called district or travellers' bungalows, or in Bengal called dâk bungalows. Travellers' bungalows are to found at Ratnagiri, also at Indapur and Kumbhargaon in the Sholapur district, Satara (probably), Nagpore, Ghazipur (empty bungalows), Robertsganj (near Mirzapur), Ballia (near Buxar), Chupra, &c. Such bungalows usually contain three or four rooms and are provided with necessary, but not luxurious furniture, and a few servants are in attendance. A small fee is charged for residence; but in the event of a stay of more than twenty-four hours being made, a new arrival has a prior claim to be accommodated over the older residents. The servants at these bungalows can usually provide plain food. Small waiting rooms are to be found at most of the stations on the various lines of railway crossing the path of the eclipse; and the railway companies would probably allow observers to occupy these, but in such cases travellers would have to make their own arrangements for living and sleeping. Failing travellers' bungalows or the waiting rooms at stations, the only plan would be to camp out, and this will probably have to be done in the great majority of cases. Tents and camp furniture can be purchased, and in some cases hired at large towns in India; and in addition the Government of India in the Military Department have promised to lend tents and the ordinary articles of camp furniture *as far as they may be available* for the use of *bonâ fide* scientific observers who may come out to India for the purpose of witnessing the total eclipse of the sun. Probably, also, tents could be procured in some instances from the Magistrates and Collectors and other officials of districts who would be certain to give every assistance in their power to observing parties. Here, again, arrangements would have to be made by each party or person as to servants, commissariat, &c. If any station were selected at a distance from large towns or headquarters of districts, arrangements for food would have to be made beforehand, for only things like fowls, eggs, milk, rice, &c., can be purchased at the smaller stations. Indian servants can, however, always be procured who are accustomed to camp life, and who can take the greater part of the responsibility in making such arrangements.

In a few cases the easily accessible sites near to lines of railway communication are situated in districts where there are European Indigo and other factories. This is especially the case in Bengal, where the line of totality actually passes through Tirhoot, &c. The managers and other European gentlemen in charge of such factories have a well-deserved reputation for almost boundless hospitality, and an observing party stationed in such a district would be certain of a warm and hearty welcome. The districts, however, in which European planters reside in India are, unfortunately for travellers, comparatively few.

THE BRITISH ASSOCIATION.

TORONTO, *August* 18.

WE are now at the opening day of the meeting, and the various parties of members have converged upon Toronto from different directions. The President, the President-elect, and a number of others, including most of the sectional officers, crossed in the *Parisian*, leaving Liverpool on August 5. During the voyage an Anthropometrical Laboratory was opened, and the heads of the *Parisians* were duly measured and recorded. Tow-nets were worked continuously day and night from the Irish Sea to the St. Lawrence, so as to obtain a section across the plankton of the North Atlantic.

Lord Lister, Sir John Evans, and the other members of the party from the *Parisian* visited Montreal on Monday, and met with a most cordial reception from the Governors, Principal and Fellows of the McGill University. After an address of welcome the party was taken round the splendidly equipped College laboratories, was entertained to luncheon, and was then taken for a drive round the town. Ottawa, with its Government experimental farm, its important Geological Museum, and its extensive timber-yards and saw-mills, was visited yesterday, when Prof. Robertson of the Agricultural Department, Prof. Bovey of McGill University, the Mayor of Ottawa, and some other citizens kindly enabled the visitors to see as much as possible in the time.

Toronto, we have been told, owes its name to the Indians, who originally called it "a place of meetings." To us it seems excellently suited for a place of meeting at the present day. The convenient system of electric tram-cars, the ample accommodation for sectional and other meetings, the natural objects of interest around, the enthusiasm and hospitality of the inhabitants, combine to give all the necessary local elements for a successful meeting.

The meeting, of course, will not be a very large one. The number is now about 1100, which may be regarded as satisfactory. The Massey Hall, in which the presidential address and the evening lectures will be delivered, is a splendid building—probably unnecessarily large for the audience. The reception room and the sectional meeting rooms are located in the various buildings of the University, surrounded by fine grounds. The Secretarium, in the same park, occupies the Wycliffe College, where Prof. and Mrs. Macallum act as hosts. In addition to private hospitality, there is a full list of garden-parties and excursions. The local authorities and the railway, steamboat and telegraph companies have with great liberality given abundant facilities for travel and intercommunication to their visitors from Europe.

This afternoon a formal welcome will be given to the Association by his Excellency the Governor-General, and by the Mayor and Council of Toronto. We find that the presidential address to-night, and the sectional addresses to-morrow, are being looked forward to by our hosts with keen interest. In order to enable those members who take a general rather than a special interest to hear as many of the presidential addresses as possible, the Sectional Committees have wisely, by re-arrangement of programmes, dovetailed the addresses so as to have less clashing than usual. For example, in the Biological Sections the address in I will take place at 10.30, that in D at 11.30, while those of H and K have been postponed till the following forenoon.

One hears in every section that the prospect of papers and interesting matter for discussion is good; a fair number of papers are contributed by Canadians and Americans, and the work in several of the sections has distinct reference to the country in which we are meeting.

W. A. HERDMAN.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. SIR WILLIAM TURNER, M.B., LL.D., D.C.L., D.SC., F.R.SS., L. AND E., PRESIDENT OF THE SECTION.

Some Distinctive Characters of Human Structure.

WHEN the British Association for the Advancement of Science held its first Canadian meeting at Montreal in 1884, the subject of Anthropology, or the Science of Man, attained on that occasion for the first time the rank of an independent Section.

It was presided over by the accomplished writer and learned anthropologist, Dr. E. B. Tylor, who selected as the subject-

matter of his opening address several prominent questions in Anthropology, with special reference to their American aspects. For example, the question of the presence of a stone age in America; whether the aborigines are descendants and representatives of man of the post-glacial period; the question of the Asiatic origin of the American Indians, and the arguments derived from anatomical structure, language, and social framework, bearing upon this theory. The traces of Asiatic influence in the picture writings of the Aztecs, correspondences in the calendar cycles of Mexico and Central America with those of Eastern Asia, and the common use of certain games of chance were also referred to.

It is not my intention, even had I possessed the requisite knowledge, to enlarge on the topics so ably discussed by my eminent predecessor. As my own studies have been more especially directed to the physical side of Anthropology, rather than to its archæological, historical, philological, moral and social departments, I naturally prefer to call your attention to those aspects of the subject which have from time to time come within the range of my personal cognisance. I have selected as the subject of my address "Some Distinctive Characters of Human Structure."

When we look at man and contrast his form and appearance with other vertebrate creatures, the first thing probably to strike us is his capability of assuming an attitude, which we distinguish by the distinctive term, the erect attitude. In this position the head is balanced on the summit of the spine, the lower limbs are elongated into two columns of support for standing on two feet, or for walking, so that man's body is perpendicular to the surface on which he stands or moves, and his mode of progression is bipedal. As a consequence of this, two of his limbs, the arms, are liberated from locomotor functions; they acquire great freedom and range of movement at the shoulder-joint, as well as considerable movement at the elbow and between the two bones of the forearm; the hands also are modified to serve as organs of prehension, which minister to the purposes of his higher intelligence. The erect position constitutes a striking contrast to the attitude assumed by fish, amphibia, and reptiles when at rest or moving, in which vertebrates the body is horizontal and more or less parallel to the surface on which they move. Birds, although far removed from the erect attitude, yet show a closer approximation to it than the lower vertebrates or even the quadrupedal mammals. But of all vertebrates, those which most nearly approximate to man in the position assumed by the body when standing and walking are the higher apes.

The various adaptations of structure in the trunk, limbs, head, and brain which conduce to give man this characteristic attitude are essential parts of his bodily organisation, and constitute the structural test which one employs in answering the question whether a particular organism is or is not human.

These adaptations of parts are not mere random arrangements, made at haphazard and without a common purpose; but are correlated and harmonised so as to produce a being capable of taking a distinctive position in the universe, superior to that which any other organism can possibly assume. If we could imagine a fish, a reptile, or a quadruped to be provided with as highly developed a brain as man possesses, the horizontal attitude of these animals would effectually impede its full and proper use, so that it would be of but little advantage to them. It is essential, therefore, for the discharge of the higher faculties of man, that the human brain should be conjoined with the erect attitude of the body. The passage of a vertebrate organism from the horizontal position, say of a fish, in which the back, with its contained spinal column, is uppermost, and the head is in front, to the vertical or erect position of a man, in which the back, with its contained spinal column, is behind, and the head is uppermost, may be taken as expressing the full range and limit of evolution, so far as the attitude is concerned, of which such an organism is capable. Any further revolution of the body, as in the backward direction, would throw the back downwards, the head backwards, and would constitute a degradation. It would not be an advance in the adaptation of structure to the duties to be discharged, but rather an approach to the relation of parts existing so generally in invertebrate organisms.

At an early period in the evolution of the human mind and intelligence an anthropomorphic conception of the Deity arose, to whom were ascribed the possession of the bodily form and attitude of man, and even human affections and passions. This idea took so firm possession of the imagination that, in the course of time, it obtained objective expression in the statues of ancient Greece and Rome and in the masterpieces of Christian art. In one of the most ancient of all books, in which is embodied the conception entertained by the Jewish writers of the Genesis of the world, and of all creatures that have life, we read that "God created man in His own image, in the image of God created He him, male and female created He them." By the association, therefore, of the human form with the idea of Deity, there was naturally present in the minds of these writers, although not expressed in precise anatomical language, a full recognition of the dignity of the human body, of its superiority to that of all other creatures, and that the human form was the crown and glory of all organic nature.

This conception of the dignity of man in nature is not confined to those writings which we are accustomed to call sacred. The immortal Greek philosopher and naturalist, Aristotle, in his treatise "On the Parts of Animals," composed at least three hundred years B.C., refers more than once to the erect attitude of man, and associates it with his "God-like nature and God-like essence." In the second century of our present era lived another Greek author, Claudius Galen, whose writings exercised for many centuries a dominating influence in medicine and anatomy, comparable to that wielded by Aristotle in philosophy. Although Galen, as has been shown by Vesalius and other subsequent anatomists, was often incorrect in his descriptions of the internal parts of the human body, doubtless because his opportunities of dissection were so scanty, he had attained a correct conception of the perfection of its external form, and he thoroughly understood that in its construction it was admirably fitted for the sentient and intelligent principle which animated it, and of which it was merely the organ. In his treatise on the use of the various parts of the body he associates the hand with the exercise of the gift of reason in man, and he speaks of it as an instrument applicable to every art and occasion, as well of peace as of war. It is, he says, the best constructed of all prehensile organs, and he gives a careful description of how both the hand as a whole and the individual digits, more especially the thumb, are brought into use in the act of grasping.[1] Galen does not indeed enter into the minute anatomical details which have been emphasised by more recent writers on the subject, but by none of these has the use of the hand and its associations with man's higher intelligence been more clearly and more eloquently expressed than by the Greek physician and philosopher seventeen centuries ago.

By the publication in 1859 of Charles Darwin's ever-memorable treatise "On the Origin of Species," an enormous impulse was given to the study of the anatomy of man in comparison with the lower animals, more especially with the apes. By many anatomists the study was pursued with the view of pointing out the resemblances in structure between men and apes; by a more limited number to show wherein they did not correspond. I well remember a course of lectures on the comparative characters of man delivered thirty-five years ago by my old master, Prof. John Goodsir, in which, when speaking of the hand of man and apes, he dwelt upon sundry features of difference between them.[2] The human hand, he said, is the only one which possesses a thumb capable of a free and complete movement of opposition. It may be hollowed into a cup and it can grasp a sphere. It is an instrument of manipulation co-extensive with human activity. The ape's hand again is an imperfect hand, with a short and feeble thumb, and with other clearly defined points of difference and inferiority to that of man. It can embrace a cylinder, as the branch of a tree, and is principally subservient to the arboreal habits of the animal. Its fingers grasp the cylinder in a series of spirals.

Here then is an important difference in the manipulative arrangements of the two hands, the advantage being with the hand of man, in regard to the greater variety of movement and adaptability, to co-ordinate it with his reasoning faculties. As showing the acuteness of perception of Galen and his complete recognition of a fundamental feature of the human hand, he also dwells on the hand being able to form a circle around a sphere, so as to grasp it on every side, and to touch it with every part of itself, whilst it can also securely hold objects that possess plane or concave surfaces. So impressed was the old Greek writer with the fitness of the hand to discharge the duties imposed on

[1] See passages translated in Dr. Kidd's "Bridgewater Treatise," 1833, and Dr. J. Finlayson's "Essay on Galen," Glasgow, 1895.

[2] "On the Dignity of the Human Body," in "Anatomical Memoirs," by John Goodsir, vol. i. p. 238, Edinburgh, 1868.

it by the higher intelligence of man that, pagan though he was, he regarded its construction as evidence of design in nature, and as a sincere hymn to the praise and honour of the Deity.

It is not my intention to dwell upon the multitudinous details of those features of structure which distinguish man from other vertebrates, for these have been considered and described by numerous writers. The leading structural differentiæ constitute the merest commonplaces of the human anatomist, and are already sufficiently imprinted on the popular mind. But it may not be out of place to refer to certain aspects of the subject which are not so generally known, and the significance of which has been brought into greater prominence by recent researches.

If we compare the new-born infant with the young of vertebrates generally, we find a striking difference in its capability of immediately assuming the characteristic attitude of the species. A fish takes its natural posture and moves freely in its element as soon as it is hatched. A chicken can stand and walk when it is liberated from the egg, though, from its wings not being developed, it is not at once able to fly. A lamb or calf can assume the quadrupedal position a few minutes after its birth. But, as we all know, the infant is the most helpless of all young vertebrates, and is months before it can stand on two feet and move freely on them. During the period of transition, from the stage of absolute dependence on others to the acquisition of the power of bipedal progression, important modifications in the structural arrangements both of the spine and lower limbs have to take place. At the time of birth the infant's spinal column exhibits only two curves; one, corresponding to the true vertebræ, extends from the upper end of the neck to the lowest lumbar vertebra, and the concavity of its curve is directed forwards; the other and shorter corresponds to the sacro-coccygeal region, and also has its concavity directed forwards. In the number and character of the curves, the new-born infant differs materially from the adult man, in whose spine, instead of one continuous curve from the neck to the sacrum, there are alternating curves, one convex forwards in the region of the neck, succeeded by one concave forwards in the region of the chest vertebræ, which again is succeeded by a marked convexity forwards in the vertebræ of the loins. The sacro-coccygeal region continues to retain the forward concavity of the new-born child. The formation and preservation of this alternating series of curves is associated with the assumption of the erect attitude, and the development of the lumbar convexity is correlated with the straightening of the lower limbs when the child begins to walk.[1]

When the child is born, the curvature of its spine in the dorso-lumbar region approximates to that of an ordinary quadruped in which there is no lumbar convexity, so that the spine in that region presents one continuous curve concave forwards. For some time after its birth the infant retains the quadrupedal character of the spinal curve in the dorso-lumbar region, and, as it acquires nervous and muscular power and capability of independent movement, its mode of progression in the early months by creeping on hands and knees approximates to that of the quadruped. It is only after it has attained the age of from a year to sixteen months that it can erect its trunk, completely extend the hip and knee joints, and draw the leg into line with the thigh, so as to form a column of support, which enables it to stand or move about on two feet. Hence there is this great difference between the young of a quadruped and that of a man, that whilst the former is born with the dorso-lumbar curve proper to its attitude, and which it retains throughout life, the child does not possess, either when born, or for some months after its birth, the characteristic spinal curves of the man. These curves are therefore secondary in their production; they are acquired after birth, and are not imprinted on the human spine from the beginning, though the capability of acquiring them at the proper time is a fundamental attribute of the human organism.[2]

It has sometimes been assumed that the acquisition of the erect attitude by the young child is due to the fostering care of the mother or nurse; that it is a matter of training, encouragement and education, without which the child would not raise itself upon its feet. I cannot, however, agree with this opinion. If one could conceive an infant so circumstanced that, though duly provided with food fitted for its nutrition and growth, it should never receive any aid or instruction in its mode of progression,

[1] Prof. Cleland, in Reports of British Association, 1863, p. 112.

[2] In his work on the "Origin and Progress of Language" (vol. i. p. 173, Edinburgh, 1773), Lord Monboddo held that the erect position in man is an acquired habit, and, like speech, is acquired with difficulty and as the result of training.

there can, I think, be little doubt that when it had gained sufficient strength it would of itself acquire the erect attitude. The greater growth in length of the lower limbs, as compared with the upper, would render it inconvenient to retain the creeping or the quadrupedal position.

We cannot lose sight of the important influence which, altogether independent of education, is exercised by parents on their offspring. The transmission of hereditary qualities, through the germ from which each individual organism is derived, is one of the fundamental and most striking properties of the germ plasm. Characters and peculiarities which appertain not only to the family of which the individual is a member, but also to the species to which he belongs, are conveyed through it from one generation to another. Hence, as the capability of assuming the erect attitude and of thus standing and moving on two feet have been attributes of the human form from its beginning, there can be little doubt that this power is potential in the human organism at the time of birth, and only requires a further development of the nervous and muscular systems to become a reality, without the aid of any special training.

The spinal column in the region of the true vertebræ consists of numerous bones joined together, and with discs of soft fibro-cartilage interposed between and connecting the bodies of adjoining vertebræ with each other. It is to their presence that the spinal column owes its flexibility and elasticity. These discs are larger and thicker in the region of the loins, where the lumbar convexity is situated, than in any other parts of the column, and there can be no doubt that the acquisition of this convexity is intimately associated with the presence of these discs.

It is a matter for observation and consideration to what extent the bodies of the vertebræ contribute to the production of this curve. A few years ago Prof. Cunningham, of Dublin,[1] and I[2] undertook much about the same time researches into the form and dimensions of the bodies of these bones. Our observations were made independently of each other and on two different series of skeletons, and as we arrived at practically the same conclusions, we may, I think, infer that, in their main features at least, these conclusions are correct.

The method followed in the investigation was to measure the diameter from above downwards of the body of each of the five lumbar vertebræ, both in front and behind. If the upper and lower surfaces of the bodies of the vertebræ were parallel to each other, it is obvious that, so far as they are concerned, the column formed by them would be straight, as is the case of a column built of hewn stones possessing similar parallel surfaces. But if the surfaces are not parallel, the body of the vertebræ is wedge-shaped; should the front of the collective series of bones have a greater vertical diameter than the back, it is equally obvious that the column would not be straight, but curved, and with the convexity forwards. From the examination of a considerable number of spinal columns of Europeans, we found that, although the vertical diameter of the bodies of the two highest vertebræ was greater behind than in front, in the two lowest the anterior vertical diameter so greatly preponderated over the posterior that the anterior vertical diameter of the bodies of the entire series of lumbar vertebræ in each spine was collectively greater than the corresponding diameter of the posterior surface. In twelve European skeletons I observed that the mean difference was between 5 and 6 mm. in favour of the anterior surface. If we are to regard the collective vertical diameter anteriorly of the five bones as equal to 100, the same diameter posteriorly is only equal to 96, which may be regarded as the lumbar index in Europeans. Dr. Cunningham obtained a similar index from the examination of a much larger number of European skeletons, and he further showed that in women the lumbar convexity forwards is more pronounced than in men. It follows, therefore, from these observations, that when the broad end of the wedge-shaped bodies is in front the bones themselves would by their form give a forward convexity to the spine in the lumbar region. But a similar wedge-shaped form is also possessed by the lower intervertebral discs in this region, and especially by that interposed between the last lumbar vertebræ and the sacrum. Hence it follows that both vertebral bodies and intervertebral discs contribute in the white races to the production of the lumbar convexity.

When we pass to the examination of the corresponding region in the spines of those races of men that we are accustomed to call

[1] "The Lumbar Curve in Man and the Apes," Cunningham, *Memoirs of the Royal Academy*, Dublin, 1886.

[2] "Report on Human Skeletons," "*Challenger* Reports," Part xlvii., 1886.

lower races, we find a remarkable and important difference. Let us take as a characteristic example of a lower race the aborigines of Australia. In their skeletons our observations have proved, that the vertical diameter of the bodies of the five lumbar vertebræ was collectively deeper behind than in front. In my series of skeletons the mean difference was between 6 and 7 mm. in favour of the posterior surface, so that they possessed the opposite condition to that which prevails in Europeans. Hence if the spine had been constructed of vertebræ only, instead of a lumbar convexity, the column would have possessed a forward concavity in that region. For this character, as shown in the skeleton only, I have suggested the descriptive term "Koilorachic."

We know, however, that elastic discs are intercalated between the bodies of the osseous vertebræ in the black races as well as in Europeans. It is necessary, therefore, to examine their spinal columns, when the intervertebral discs are in position, in order to obtain a proper conception of the character of the curve in the living man.

A few years ago Prof. Cunningham had the opportunity of studying the spinal column of an aboriginal Australian,[1] in which the intervertebral discs had been preserved in their proper position, in relation to the bones, without losing their flexibility, or their natural shape and thickness. He found that, whilst the bodies of the lumbar vertebræ were longer than in Europeans, the proportion of intervertebral disc to vertebral body was distinctly less, so that the disc appeared to be reduced in depth, in relation to the greater vertical diameter of the vertebral body. Notwithstanding this difference, as compared with the white man, the Australian spine had a marked lumbar convexity which showed no material difference from that seen in Europeans. As the lumbar curve was not due to the wedge-shaped form of the bodies of the vertebræ, it was therefore produced solely by the strong wedge-shape of the intervertebral discs, and was not, as in Europeans, a product of a combination of both these factors. The spinal column, when complete, is not therefore koilorachic in the lumbar region.

The greater vertical diameter of the bodies of the lumbar vertebræ behind them in front, as compared with Europeans, is not limited to the Australians, but is participated in by other black races, as the now extinct Tasmanians, the Bushmen, Andaman Islanders, and Negroes, which, if tested solely by the measurements of the skeleton, would also be koilorachic. But in these races intervertebral discs are also present, and there can be no doubt that through the compensating influence of the wedge-shaped discs, with their deeper ends in front, the lumbar curve is in them also convex forwards. It is clear, therefore, that in the black races the intervertebral discs play relatively a more important part in the production of the lumbar curve than in Europeans.

One of the acquirements of civilisation is the wearing of clothes, and fashion frequently prescribes that they should be tight-fitting and calculated to restrict motion in and about the spinal column. In savage races, on the other hand, clothing is often reduced to a minimum, and when worn is so loose and easy as in no way to hamper the movements of the body. The spinal column retains therefore in them much more flexibility, and permits the greater measure of freedom in the movements of the trunk, which is found in savage man, and has often been referred to by travellers.

It used to be considered that the possession of a lumbar convexity in the spinal column was the exclusive privilege of man, and was shared in by no other vertebrate. There can be no doubt that it attains a marked development in the human spine, and as such is associated with the erect posture. But the observations of Cunningham on the spinal column of apes, more especially the anthropoid group, made in fresh specimens, in which the intervertebral discs were in place, have proved that in the Chimpanzee the lumbar convexity is probably as strongly pronounced as in the adult man. In a Chimpanzee, two years old, the development is more advanced than in a child of the same age. The lumbar convexity is established at an earlier age than in the child, for it would seem as if the Chimpanzee attained its maturity at a younger period of life than the human being. In the Orang the lumbar curve is more feeble than in Man and the Chimpanzee, and in the specimen described by Cunningham resembled that of a boy six years old. In a fresh specimen of the Gibbon, examined by the same anatomist, the lumbar curve was intermediate between the Chimpanzee and the Orang.

In 1888, I purchased the bones of an adult male Gorilla, in which the vertebræ were in position and connected together by the dried intervertebral discs. This condition is of course not so satisfactory, for the study of the spinal curves, as if the specimen had been fresh, and with the discs retaining their natural flexibility and elasticity. But it was quite obvious that the spine possessed an alternating series of convex-concave curves from above downwards. The cervical and lumbar convexities, more especially the latter, did not project so far forwards as in man, and the dorsal concavity was not so deep. The most projecting part of the lumbar convexity was at the junction of the bodies of the third and fourth lumbar vertebræ and their intermediate disc. A vertical line drawn downwards from the most prominent part of this convexity fell in front of the coccyx. When prolonged upwards it passed in front of the bodies of the dorsal vertebræ, and intersected the body of the sixth cervical vertebra, so that the bodies of the vertebræ, higher than the sixth, were directed obliquely from below upwards and forwards in front of the vertical line.

The dried state of the discs did not enable one to determine precisely the proportion in which they entered into the formation of the length of the column, but the vertical diameter of the interlumbar and lumbo-sacral discs was obviously not as great as in the human spine. On the other hand, the vertical diameter of the bodies of the lumbar vertebræ was greater than in man, so that the length of the lumbar spine, and possibly its degree of convexity, were due more to the bodies of the vertebræ than to the elastic discs interposed between them. The Gorilla corresponds with the Chimpanzee in having longer vertebral bodies and shorter intervertebral discs than in man.

Without going into the question whether a lumbar convexity exists in the tailed monkeys, the determination of which with precision is a matter of some difficulty, it must be obvious that the presence of this convexity can no longer be regarded as the exclusive prerogative of man. It undoubtedly forms an important factor in the study of the erect attitude; but in order that man should acquire and be able to retain his distinctive posture, something more is necessary than the possession of a spinal column with a curve in the lumbar region convex forwards.

Our attention should now be directed to the lower limbs, more especially to the two segments of the shaft, which we call thigh and leg.

If we look at a quadruped we see that the thigh is bent on the trunk at the hip joint, and that the leg is bent on the thigh at the knee joint; whilst the foot forms more or less of an angle with the leg, and the animal walks either on the soles of its feet or on its toes. In the Anthropoid apes there is also distinct flexure both of the hip and knee joints, so that the leg and thigh are set at an angle to each other, and the foot is modified, through a special development of the great toe, into an organ of prehension as well as of support. When we turn to the human body we find that in standing erect the leg and thigh are not set at an angle to each other, but that the leg is in line with and immediately below the thigh, that both hip and knee joints are fully extended, so that the axis of the shaft of the lower limb is practically continuous with the axis of the spine. The foot is set at right angles to the leg, and the sole is in relation to the ground. The vertical axis of the shaft of the lower limb, the extended condition of the hip and knee joints, and the rectangular position of the foot to the leg are therefore fundamental to the attainment of the erect attitude of man.

In narratives of travel by those who have studied the Penguins in their native habitats, you may read that these birds may be seen standing on the rocks on the coasts which they frequent, in rows, like regiments of soldiers, and the idea has become implanted in the minds of many that they can stand erect. Even so accomplished a writer and acute a critic as the late Mr. G. H. Lewes thought that the Penguins had the vertical attitude when standing, and that some mammals, as the Jerboa and Kangaroo, very closely approached to it. The attitude of man was, he considered, merely a question of degree, and did not express a cardinal distinction.[1]

In arriving at this conclusion, however, only the external appearance of the birds and mammals referred to by him can have been looked at. If the skin and flesh be removed, and

[1] *Proc. Roy. Soc. London*, January 24, 1889, vol. xlv.; also see *Journal of Anatomy and Physiology*, vol. xxiv. 1890.

[1] Aristotle, "A Chapter from the History of Science," p. 309, London 1864.

the arrangement of the constituent parts of the skeleton be studied, it will be seen that the axis of the spine in them, instead of being vertical, is oblique, and that there is no proper lumbar convexity; that the hip and knee joints, so far from being extended, are bent: that the thigh is not in the axis of the spine, and that the leg, instead of being in a vertical line with the thigh, is set at an acute angle to it. The so-called vertical attitude therefore in these animals is altogether deceptive. It does not approximate to, and can in no sense be looked upon as equivalent to, the erect attitude in man.

We may now consider what agents come into operation in changing the curve of the spine from the concavity forwards, found in the new-born infant, to the alternating series of curves so characteristic of the adult. The production of the lumbar convexity is, without doubt, due to structures associated with the spine, the pelvis and the lower limbs, whilst the cervical convexity is due to structures acting on the spine and the head.

There can, I think, be little doubt that muscular action plays a large part in the production of the cervical and lumbar convexities. The study of the muscles, associated with and connected to the spinal column, shows that large symmetrically arranged muscles, many of which are attached to the neural arches and transverse processes of the vertebræ, extend longitudinally along the back of the spine, and some of them reach the head. On the other hand, those muscles which lie in front of the spine, and are attached to the vertebræ, are few in number, and are practically limited to the cervical and lumbar regions, in which the spine acquires a convexity forwards.

It has already been pointed out that the formation of the lumbar convexity is correlated with the power of extending the hip joints and straightening the lower limbs. When these joints are in the position of extension, an important pair of muscles called the "psoæ," which reach from the small trochanter of the femur to the bodies and transverse processes of the lumbar vertebræ, are in a state of tension. In the act of extending the hip joints so as to raise the body to the erect position, the opposite ends of these muscles are drawn asunder, and the muscles are stretched and elongated, so that they necessarily exercise traction upon the lumbar spine. Owing to its flexibility and elasticity, a forward convexity is in course of time produced in it in this region. By repeated efforts the convexity becomes fixed and assumes its specific character.

Along with the changes in the spinal column, a modification also takes place in the inclination of the pelvis during the extension of the hip joints and the straightening of the lower limbs. The muscle called "iliacus" is conjoined with the psoas at its attachment to the small trochanter, but instead of being connected to the spinal column by its upper end, it is attached to the anterior surface of the ilium. It exercises traction therefore on that bone, draws it forwards and increases the obliquity of the pelvic brim. This in its turn will react on the lumbar spine and assist in fixing its convexity.

By some anatomists great importance has been given to the "ilio-femoral band," situated in the anterior part of the capsular ligament of the hip joint, as causing the inclination of the pelvis, and in promoting the lumbar curve. This band is attached by its opposite ends to the femur and the ilium. As the hip joint is being extended, the ends are drawn further apart, the band is made tense, and the ilium might in consequence be drawn upon, so as to affect the inclination of the pelvis. As the ligament has no attachment to the spinal column, it cannot draw directly on it, but could only affect it indirectly through its iliac connections. It can therefore, I think, play only a subordinate part in the production of the lumbar curve.

Contemporaneous with the straightening of the lower limbs and the extension of the hip joints, the spinal column itself is elevated by muscles of the back, named "erectores spinæ," which, taking their fixed points below, draw upon the vertebræ and ribs and erect the spine. The lumbar convexity is the form of stable equilibrium which the flexible spinal column tends to take under the action of the muscular forces which pull upon it in front and behind. It is probably due to the fact that the average pull, per unit of length, of the psoæ muscles attached in front is greater than the average pull, per unit of length, of the muscles attached behind in the same region.

The muscles which lie on the back of the neck and which are attached to the occipital part of the skull, when brought into action, will necessarily affect the position of the head. The new-born infant has no power to raise the head, which is bent forward, so that the chin is approximated to the chest. As it acquires strength the head becomes raised by the muscles of the back of the neck, and the flexible spine in the cervical region loses its primary curve, concave forwards, and gradually assumes the cervical convexity. The formation of this curve is, I believe, assisted by the anterior recti muscles, the lower ends of which are attached to the front of the vertebræ, whilst their upper ends are connected to the basi-occipital. In the elevation of the head the opposite ends of the muscles are drawn apart, which would exercise a forward traction upon the cervical vertebræ. The production of the cervical convexity precedes the formation of the lumbar curve, for an infant can raise its head, and take notice of surrounding objects, months before it can stand upon its feet

We shall now look at the bones in the thigh and leg, which possess characters that are distinctively human, and which are associated with the erect posture. These characters can be more clearly recognised when the bones are contrasted with the corresponding bones of the large Anthropoid apes.

As compared with the ape, the shaft of the human thigh bone is not so broad in relation to its length; when standing erect the shaft is somewhat more oblique, it is more convex forwards and generally more finely modelled, and it has three almost equal surfaces, the anterior of which is convex. But, further, a strong ridge (linea aspera) extends vertically down its posterior surface; so that a section through the shaft is triangular, with the two anterior angles rounded and the posterior prominent. In the Gorilla, Chimpanzee, and Orang, the shaft is flattened from before backwards, and the linea aspera is represented by two faint lines, separated from each other by an intermediate narrow area. A section through the shaft approximates to an ellipse. In the Gibbon the femur is greatly elongated, and the shaft is smooth and cylindriform. The linea aspera is for the attachment of powerful muscles, which are more closely aggregated in man than in apes, so that the human thigh possesses more graceful contours.

In the human femur the shaft is separated from the neck by a strong anterior intertrochanteric ridge, to which is attached the ilio-femoral ligament of the hip joint, which, by its strength and tension, plays so important a part in keeping the joint extended when the body is erect. In the Anthropoid apes this ridge is faint in the Gorilla, and scarcely recognisable in the Orang, Gibbon, and Chimpanzee, and the ilio-femoral ligament in them is comparatively feeble. It may safely therefore be inferred that in apes, with their semi-erect, crouching attitude, the ilio-femoral band is not subjected to, or capable of sustaining, the same strain as in man.

The head of the thigh bone is also distinctive. In the apes the surface covered by cartilage is approximately a sphere, and is considerably more than a hemisphere. It is sharply differentiated from the neck by a definite boundary, and it has a mushroom-like shape. In man the major part of the head is also approximately a sphere; but, in addition, there is an extension outwards of the articular area on the anterior surface and upper border of the neck of the bone. The form of this extended area differs from the spherical shape of the head in general. The curvature of a normal section of its surface has a much larger radius than the curvature of a normal section of the head, near the attachment of the ligamentum teres.

The amount of this extended area varies in different femora, but as a rule it is larger and more strongly marked in Europeans than in the femora of some savages which I have examined. When the joint is in the erect attitude, the area is in contact with the back of the iliac part of the ilio-femoral ligament. It provides a cartilaginous surface which, during extension of the joint, is not situated in the acetabulum, but, owing to the centre of gravity falling behind the axis of movement, is pressed against that ligament, and contributes materially to its tension. It is associated with the characteristic position of the human hip joint in standing, and may be called appropriately the extensor area. When the femur is abducted it passes within the acetabulum. The head of the femur in man is not so sharply differentiated from the neck as in the Anthropoid apes, especially in the region of the extensor articular area.

Both man and apes possess at the lower end of the femur a trochlear or pulley-like surface in front for the patella, and two condyles for the tibia. In the apes the trochlea is shallow, and the concave curve from side to side is a segment of an approximate circle, with a large radius. In man the trochlea is much deeper, and the inner and outer parts of the curve deviate considerably from a circle, and are not symmetrical; the outer part

is wider and extends higher on the front of the bone than the inner part, whilst the direction of the curve changes towards the edges of the trochlea.

In the apes the articular surface of the inner condyle is very markedly larger than that of the outer condyle, both in breadth and in the extent of its backward curve, which winds upwards on the posterior part of the condyle, so that the articular surface is continued on to its upper aspect. The curve of the outer condyle is much sharper, and the condyle does not project so far backwards; its articular surface is not prolonged so high on the back of the bone. In the apes, therefore, the inner is the more important condyle in the construction of the knee joint, and the marked extension of its articular area backwards and upwards is associated with the position and movements of the knee in flexion. In the ape the thigh is more rotated outwards than in man, and the inner condyle is directed to the front of the limb.

In man there is not nearly the same disproportion in the size of the two condyles as in the apes. I have occasionally seen in man the articular area of the inner broader than that of the outer condyle, but more usually the outer is appreciably wider. The backward curve of the outer condyle is also prolonged somewhat higher than that of the inner, and thus the condition of the two condyles is the reverse of that found in the ape. It should, however, be stated, as has been shown by Dr. Havelock Charles (*Journal of Anatomy and Physiology*, vol. xxviii.), that in persons, who habitually rest in the squatting position, an upward extension of the articular area of the inner condyle exists, which is associated with the acute flexion of the knee whilst squatting. In man, the outer condyle, when seen in profile, is, as compared with the inner, more elongated antero-posteriorly than in the Gorilla. The approximate equality in the size of the two condyles in man is, without doubt, associated with the extension of the knee joint in the erect attitude, and with the more equable distribution of the weight of the body downwards on the head of the tibia. In the ape the intercondylar fossa, in relation to the size of the bones, is wider in front than in man; but it is wider behind in man than in the ape, for in the latter the inner condyle inclines nearer to the outer condyle than in man.

In man, when the knee joint is extended, the tibia is slightly rotated outwards on the femoral condyles, and the joint is fixed, partly by the tension of the lateral and posterior ligaments and the interior crucial ligament, and partly by the general tension of the muscles and fasciæ around the joint. So long as these structures remain tense, the joint cannot be bent, and no lateral movement, or rotation, is permitted. The fixation of the joint is of fundamental importance in the act of standing. Free rotation of the human knee can only take place when the joint is acutely bent.

In apes, the joint cannot be fully extended; its natural position, when the animal is standing, is partial flexion, and in this position a limited rotation is permitted, which can be greatly increased when the joint is more completely bent. In rotating the leg on the thigh the inner condyle is apparently the pivot. The rotation facilitates the use of the foot as an organ of prehension, and assists the ape to turn the sole inwards and forwards when holding an object. These movements produce results, which approximate to those occasioned by pronation and supination of the radius on the ulna, in the movements of the forearm and hand.

In the Anthropoid apes, the head of the tibia slopes very decidedly backwards at the upper end of the shaft, so that its axis forms an angle with that of the shaft, and the head may be described as retroverted. If the shaft of the tibia were held vertically, the articular surface for the inner condyle would also slope downwards and backwards, and to a greater degree than that for the outer condyle. But in the natural semiflexed position of the ape's knee the condylar articular surfaces of the tibia are essentially in the horizontal plane.

In the human tibia the axis of the head is, as a rule, almost in line with that of the shaft, and the backward and downward slope of the inner articular surface is not so great as in the ape. In some human tibiæ, however, well-marked retroversion of the head has been seen. In skeletons referred to the Quaternary period of the geologist, this character has been noticed by MM. Collignon, Fraipont, and Testut, and the inference has been drawn that the men of that period could not extend the knee joint and walk as erect as modern man. It has, however, been shown by Prof. Manouvrier (*Mémoires de la Société d'Anthropologie de Paris*, 1890) and Dr. Havelock Charles (*Journal of Anatomy and Physiology*, vol. xxviii.) that this condition of the tibia is not uncommon in some races of men, in whom there can be no question that the attitude is erect when standing. Dr. Charles has associated the production of retroversion to the habit in these races of resting on the ground in the position of squatting. I have found in the tibiæ of the people of the Bronze Age that retroversion of the head of the tibia is not uncommon. In five specimens the backward slope of the head formed with the vertical axis of the shaft an angle which ranged in the several bones from 20° to 30°. But when these tibiæ were put into the erect position alongside of similarly placed modern European bones, the condylar articular surfaces were seen to approximate to the horizontal plane in all the specimens. In order, therefore, that retroversion of the head of the tibia should be associated with inability to extend the knee joint, it is obvious that the articular surfaces should have a marked slope downwards and backwards, as is the case in the Anthropoid apes, when the shaft of the tibia is held in a vertical plane.

I shall now proceed to the examination of the human foot (pes), and in order to bring out more clearly its primary use as an organ of support and progression, I shall contrast it with the human hand (manus) and with the manus and pes in apes. In man, while standing erect, the arched sole of the foot is directed to the ground, and rests behind on the heel and in front on pads, placed below and in line with the metatarso-phalangeal joints, the most important of which is below the joint associated with the great toe. It is therefore a plantigrade foot. The great toe (hallux) lies parallel to the other toes, and from its size and restricted movements gives stability to the foot.

The ape's foot agrees with that of man in possessing similar bones and almost similar soft parts; but it differs materially as to the uses to which it can be put. Some apes can undoubtedly place the sole upon the ground, and in this position use the foot both for support and progression; though the Orang, and to some extent other Anthropoid apes, rest frequently upon the outer edge of the foot. But in addition these animals can use the foot as a prehensile organ like the hand. The old anatomist Tyson, in his description of a young Chimpanzee ("Anatomy of a Pygmie," 1699, p. 13), spoke of the pes as "liker a hand than a foot" and introduced the term "quadrumanous," four-handed, to designate this character. This term was adopted by Cuvier and applied by him to apes generally, and has long been in popular use. The eminent French anatomist was, however, quite alive to the fact that though the pes was capable of being used as a hand, yet that it was morphologically a foot, so that the term was employed by him to express a physiological character.

In the ape, the great toe, instead of being parallel to the other toes as in man, is set as an angle to them, not unlike the relation which the thumb (pollex) bears to the fingers in the human hand. It is able, therefore, to throw the hallux across the surface of the sole in the prehensile movement of opposition. As it can at the same time bend the other toes towards the sole, it also has the power of encircling an object more or less completely with them. By the joint action of all the toes a powerful grasping organ is produced, more important even than its hand, in which the thumb is feebly developed.

It has sometimes been assumed that the human foot is also a prehensile instrument as well as an organ of support. In a limited sense objects can undoubtedly be grasped by the human toes when bent towards the sole. In savages, this power is preserved to an extent which is not possible in civilised man, in whom, owing to the cramping, and only too frequently the distorting influence, exercised by badly fitting boots and shoes, the proper development of the functional uses of the toes is impeded and their power of independent movement is often destroyed.

Even in savages who have never worn shoes, the power of grasping objects by the toes cannot be regarded as approximately equal in functional activity and usefulness to the range of movement possessed by the ape. The four outer toes are so short and comparatively feeble, that they cannot encircle an object of any magnitude. But, what is even more important, the great toe cannot be opposed to the surface of the sole, in the way that an ape can move its hallux or a man his thumb. Savage man can no doubt pick up an object from the ground with the great toe. Many of us have doubtless seen, among civilised men, persons who have had the misfortune to be born without

arms, or who have accidentally lost them in early life, who have trained themselves to hold a pen, pencil, brush, or razor with the foot, and to write, draw, paint, or even shave. But in these cases the object is held between the hallux and the toe lying next to it, and not grasped between the great toe and the sole of the foot by a movement of opposition.

If we compare the anatomical structure of the human foot with that of the foot of the ape, though the bones, joints, and muscles are essentially the same in both, important differences in arrangement may be easily recognised, the value of which will be better appreciated by first glancing at the thumb. Both in man and apes the thumb is not tied to the index digit by an intermediate ligament, which, under the name of "transverse metacarpal," binds all the fingers together, and restricts their separation from each other in the transverse plane of the hand. The great toe of the ape, similarly, is not tied to the second toe by a "transverse metatarsal ligament," such as connects together and restricts the movements of its four outer toes in the transverse plane of the foot. The hallux of the ape is therefore set free. It can, like the thumb of man and ape, be thrown into the position of opposition and be used as a prehensile digit. Very different is the case in the human foot, in which the hallux is tied to the second toe by a continuation of the same transverse metatarsal ligament which ties the smaller toes together. Hence it is impossible to oppose the great toe to the surface of the sole in the way in which the thumb can be used, and the movements of the digit in the transverse plane of the foot are also greatly restricted.

The development of a connecting transverse band, for the restriction of the movements of the great toe in man, is not the only anatomical structure which differentiates it from the hallux of an ape, or the thumb in the hand. In the manus both of man and apes the joint between the metacarpal bone of the thumb and the bone of the wrist (trapezium) is concavo-convex, or saddle-shaped, and permits of a considerable range of movement in certain directions, and notably the movement of opposition. A joint of a similar configuration, permitting similar movements, is found in the pes of the ape between the metatarsal of the hallux and the tarsal bone with which it articulates. In the foot of man, on the other hand, the corresponding joint is not saddle-shaped, but is almost plane-surfaced, and consequently the range of movement is slight, and is little more than the gliding of one articular surface on the other.

One of the chief factors in the production of the movement of opposition in the manus of man and apes is a special muscle, the opponens pollicis, which, through its insertion into the shaft of the metacarpal bone of the thumb, draws the entire digit across the surface of the palm. In the foot of the Anthropoid apes there is not complete correspondence in different species in the arrangement of the muscles which move the great toe. In the Orang the abductor hallucis, in addition to the customary insertion into the phalanx, may give rise to two slips, one of which is inserted into the base and proximal part of the first metatarsal bone, and the other into the radial border of its shaft for a limited distance; these slips apparently represent an imperfect opponens muscle, which acts along with the adductor and short flexor muscle of the great toe. In the other Anthropoid apes, the muscle seems to be altogether absent, and the power of opposition is exercised solely by the adductor and the flexor brevis hallucis, the inner head of the latter of which is remarkably well developed.[1] In the human foot there is no opponens hallucis, and the short flexor of the great toe is, in relation to the size of that digit, comparatively feeble, so that no special provision is made for a movement of opposition.

The character and direction of the movements of the digits both in hand and foot are imprinted on the integument of palm and sole. In the palm of the human hand the oblique direction of the movements of the fingers towards the thumb, when bent in grasping an object, is shown by the obliquity of the two great grooves which cross the palm from the root of the index to the root of the little finger. The deep curved groove, extending to the wrist, which marks off the eminence of the ball of the thumb from the rest of the palm, is associated with the opponent action of the thumb, which is so marked in man that the tip of the thumb can be brought in contact with a large part of the palmar surface of the hand and fingers. Faint longitudinal grooves in the palm, situated in a line with the fingers, express slight folds which indicate, where the fingers are approximated to or separated from each other, in adduction and abduction. In some hands a longitudinal groove marks off the muscles of the ball of the little finger from the rest of the palm, and is associated with a slight opponent action of that digit; by the combination of which, with a partial opposition of the thumb, the palm can be hollowed into a cup—the drinking-cup of Diogenes.

[1] For a comparative description of the muscles of the hand and foot of the Anthropoid apes consult Dr. Hepburn's memoir in *Journal of Anatomy and Physiology*, vol. xxvi.

These grooves are present in the infant's hands at the time of birth, and I have seen them in an embryo, the spine and head of which were not more than 90 mm. (three and a half inches) long. They appear in the palm months before the infant can put its hand to any use; though it is possible that the muscles of the thumb and fingers do, even in the embryo, exercise some degree of action, especially in the direction of flexion. These grooves are not therefore acquired after birth. It is a question how far the intra-uterine purposeless movements of the digits are sufficient to produce them; but even should this be the case, it is clear that they are to be regarded as hereditary characters transmitted from one generation of human beings to another. They are correlated with the movements of the digits, which give the functional power and range of movement to the hand of man.

In the palm of the hand of the Anthropoid apes grooves are also seen, which differ in various respects from those in man, and which are characteristic of the group in which they are found. In these animals the palm is traversed by at least two grooves from the index border to that of the minimus. In the Gibbon they are oblique, but in the Gorilla, Chimpanzee, and Orang they are almost transverse, which implies that in flexion the fingers do not move so obliquely towards the comparatively feeble thumb as they do in man. The curved groove which limits the ball of the thumb is present, but on account of the less development of that eminence, it is not so extensive as in man. The longitudinal grooves in the palm are deeper than in the human hand, and in the Gorilla and Orang a groove differentiates the eminence associated with the muscles of the little finger from the adjoining part of the palm. The character and direction of these grooves are such as one would associate with the hand of an arboreal animal, in which the long fingers are the chief digits employed in grasping an object more or less cylindrical, like the branch of a tree, and in which the thumb is a subordinate digit. I have not had the opportunity of examining the palm of the embryo of an Anthropoid ape, but in that of an embryo Macaque monkey I have seen both the groove for the ball of the thumb which marks its opposition, and the transverse and longitudinal grooves in the palm which are correlated with the movements of the fingers. In apes, therefore, as in man, these grooves are not acquired after birth, but have an hereditary signification.

We may now contrast the grooves in the skin of the sole of the human foot with those which we have just described in the palm. For this purpose the foot of an infant must be selected as well as that of an older person in which the toes have not been cramped and distorted by ill-fitting shoes.[1]

The toes are marked off from the sole proper by a deep diagonal depression, which corresponds with the plane of flexion of the first and second phalanges. Behind this depression, and on the sole proper, is a diagonal groove, which commences at the cleft between the great and second toes, and reaches the outer border of the foot. It is seen in the infant, but disappears as the skin of the foot becomes thickened from use and pressure. This groove marks the plane of flexure of the first phalanges on the metatarsal bones of the four smaller toes. Associated with its inner end is a short groove which curves to the inner border of the foot, and marks off the position of the joint between the first phalanx and the metatarsal bone of the great toe. The groove indicates the movements of the great toe in flexion, and in adduction to, or abduction from, the second toe. It has sometimes erroneously been regarded as the corresponding groove in the foot to the deep curved groove in the hand, which defines the muscles of the ball of the thumb and is associated with the movement of opposition. This is not its real character, for the chief joint concerned in opposition

[1] These grooves have been described generally by the late Prof. Goodsir ("Anatomical Memoirs," vol. i., 1868); by myself in a lecture on hands and feet ("Health Lectures," Edinburgh, 1884); and by Mr. Louis Robinson, the last named of whom has called special attention to their arrangement in the feet of infants (*Nineteenth Century*, vol. xxxi., 1892, p. 795). The integumentary grooves in both hands and feet of men and apes have also been described and figured in detail by Dr. Hepburn in *Journal of Anat. and Phys.*, vol. xxvii. 1893, p. 112.

is that between the metacarpal bone and the corresponding carpal bone, and not that between the metacarpal bone and the phalanx. In addition, one, or it may be two faint grooves run from within outwards near the middle of the sole. In the infant's foot a groove also extends longitudinally in the centre of the foot. The grooves on the integument of the sole are in harmony with the inner anatomy of the foot, and confirm the statement, already made, that the great toe in man cannot be opposed to the sole, as the thumb can to the palm, for the great curved groove expressing the movement of opposition is wanting.

In the apes, the condition of the tegumentary grooves in the sole is very different from the human foot. In the Anthropoid group, the ball of the great toe, with its muscles, is marked off by a deep curved groove, which extends from the margin of the cleft between it and the second toe, backwards along the middle of the sole almost as far as the heel. Its depth and extent are associated with the powerful opponent, or grasping action of the hallux. Two other grooves, in front of that just described, pass obliquely across the sole from the cleft between the hallux and the second toe, and reach the outer border of the foot. They are associated with the movements of the four smaller toes, and their obliquity shows that, when the foot is used as a prehensile organ, the object is grasped not only by the great toe being moved towards the sole, but by the smaller toes being moved towards the hallux. From these arrangements it is obvious that the pes of the ape is, physiologically speaking, a foot-hand, it is pedimanous. Though anatomically a foot, it can be used not only for support and progression, but for prehension, and, for the latter-named office, the hallux is a more potent digit in the foot than is the pollex in the hand. The external rotation of the thigh at the hip joint, and the power of rotating the leg inwards on the thigh at the knee joint, contribute to make the foot of the ape a more important prehensile instrument, and enable the animal to use it more efficiently for this purpose when sitting, than would have been the case if there had been no contributory movements at the hip and knee.

The power of assuming the erect attitude, the specialisation of the upper limbs into instruments of prehension, and of the lower limbs into columns of support and progression, are not in themselves sufficient to give that distinction to the human body which we know that it possesses. They must have coordinated with them the controlling and directing mechanism placed in the head, known as the brain and organs of sense.

The head, situated at the summit of the spine, holds a commanding position. Owing to the joints for articulation with the atlas vertebra being placed on the under surface of the skull, and not at the back of the head, and to the great reduction in the size of the jaws, as compared with apes and quadrupeds generally, the head is balanced on the top of the spine. The ligaments supporting it and connected with it are comparatively feeble, and do not require for their attachment strong bony ridges on the skull, or massive projecting processes in the spine, such as one finds in apes and many other mammals. The head with the atlas vertebra can be rotated about the axis vertebra by appropriate muscles. The face looks to the front, the axis of vision is horizontal, and the eyes sweep the horizon with comparatively slight muscular effort.

The cranial cavity, with its contained brain, is of absolutely greater volume in man than in any other vertebrate, except in the elephant and in the large whales, in which the huge mass of the body demands the great sensory-motor centres in the brain to be of large size. Relatively also to the mass and weight of the body, the brain in man may be said to be in general heavier than the brains of the lower vertebrates, though it has been stated that some small birds and mammals are exceptions to this rule.

We have abundant evidence of the weight of the brain in Europeans, in whom several thousand brains have been tested. In the men, the average brain-weight is from 49 to 50 oz. (1390 to 1418 grm.). In the women, from 44 to 45 oz. (1248 to 1283 grm.). The difference in weight is doubtless in part correlated with differences in the mass, weight, and stature of the body in the two sexes, although it seems questionable if the entire difference is capable of this explanation. It is interesting to note that even in new-born children the boys have bigger heads and heavier brains than the girls. Dr. Boyd gives the average for the girl infants as 10 oz., and for boys 11·67 oz. A distinction in the brain weight of the two sexes is obviously established, therefore, before the child is born, and is not to be accounted for by the training and educational advantages enjoyed by the male sex being superior to those of the female sex.

The brains of a number of men of ability and intellectual distinction have been weighed, and ascertained to be from 55 to 60 oz. In a few exceptional cases, as in the brains of Cuvier and Dr. Abercrombie, the weight has been more than 60 oz.; but it should also be stated that brains weighing 60 oz. and upwards have occasionally been obtained from persons who had shown no sign of intellectual eminence.

On the other hand, it has been pointed out by M. Broca and Dr. Thurnam, that if the brain falls below a certain weight it cannot properly discharge its functions. They place this minimum weight for civilised people at 37 oz. for the men, and 32 oz. for the women. These weights are, I think, too high for savage men, more especially in the dwarf races. We may, however, safely assume that if the brain-weight in adults does not reach 30 oz. (851 grm.), it is associated with idiocy or imbecility. There would seem, therefore, to be a minimum brain-weight, which is necessary in order that the mental functions may be actively discharged.

We have unfortunately not much evidence of the weight of the brain in the uncultivated and savage races. The weighings made by Tiedemann, Barkow, Reid, and Peacock give the mean of the brain in the negro as between 44 and 45 oz., a weight which corresponds with that of European women; whilst in the negress the mean weight is less than in the female sex in Europeans. In two Bush girls from South Africa—representatives of a dwarf race—the brain is said to have been 34 and 38 oz. respectively.[1]

From the weighings which have been published of the brains of the Orang and Chimpanzee, it would seem that the brain-weight in these apes ranges from 11 to 15 oz. (312 to 426 grm.), and the brain-weight appears to be much about the same in the Gorilla. These figures are greatly below those of the human brain, even in so degraded a people as the dwarf Bush race of South Africa. They closely approximate to the weight of newly-born male infants, in whom, as has just been stated, the average weight was 11·67 oz. For the purposes of ape-life, the low brain-weight is sufficient to enable the animal to perform every function of which it is capable. Its muscular and nervous systems are so accurately coordinated that it can move freely from tree to tree, and swing itself to and fro; it can seize and retain objects with great precision, and can search for and procure its food. In all these respects it presents a striking contrast to the infant, having an almost similar brain-weight, which lies helpless on its mother's knee.

Another line of evidence, of which we may avail ourselves, in order to test the relative size of the brain in the different races of men and in the large apes is to be obtained by determining the internal capacity of the cranium. Examples of the brains of different races (except Europeans) are few in number in our collections, but the crania are often well represented, the volume of the cavity in which the brain is lodged can be obtained from them, and an approximate conception of the size and weight of the brain can be estimated. In pursuing this line of inquiry, account has of course to be taken of the space occupied by the membranes investing the brain, by the blood vessels and the cerebro-spinal fluid. A small deduction from the total capacity will have to be made on their behalf.

There is a general consensus of opinion amongst craniologists that the mean internal capacity of the cranium in adult male Europeans is about 1500 c.c. (91·5 cub. in.). The mean capacity of the cranium of fifty Scotsmen that I have measured by a method, which I described some years ago,[2] was 1493 c.c. (91·1 cub. in.). The most capacious of these skulls was 1770 c.c., and the one with the smallest capacity was 1240 c.c. Thus, in a highly civilised and admittedly intellectual people, the range in the volume of the brain-space amongst the men was as much as 530 c.c. in the specimens under examination, none of which was known or believed to be the skull of an idiot or imbecile, whilst some were known to be the crania of persons of education and position. In twenty-three Scotswomen the mean capacity was 1325 c.c., and the range of variation was from a maximum 1625 to a minimum 1100 c.c.—viz., 525 c.c.

Again I have taken the capacity, by the same method, of a number of crania of the Australian aborigines, a race incapable

[1] Sir R. Quain in *Pathological Transactions*, 1850, p. 182, and Messrs. Flower and Murie in *Journal of Anatomy and Phys.*, vol. i. p. 206.

[2] Human Crania, *Challenger* Reports, Pt. xxix., 1884, p. 9.

apparently of intellectual improvement beyond their present low state of development. In thirty-nine men the mean capacity was only 1280 c.c. (78·1 cub. in.). The maximum capacity was 1514 c.c., the minimum was 1044 c.c. The range of variation was 470 c.c. In twenty-four women the mean capacity was 1115·6 c.c., the maximum being 1240 and the minimum 930, and the range of variation was 310 c.c. It is noticeable that in this series of sixty-three Australian skulls, all of which are in the Anatomical Museum of the University of Edinburgh, eight men had a smaller capacity than 1200 c.c., and only four were above 1400 c.c. Of the women's skulls ten were below 1100 c.c., four of which were between 900 and 1000 c.c., and only three were 1200 c.c. and upwards.

Time does not admit of further detail on the cranial capacities of other races of men. Sufficient has been said to show the wide range which prevails, from the maximum in the Europeans to the minimum in the Australians, and that amongst persons presumably sane and capable of discharging their duties in their respective spheres of activity; for we must assume that the crania of the Australians, having the small capacities just referred to, were yet sufficiently large for the lodgment of brains competent to perform the functions demanded by the life of a savage. From a large number of measurements of capacity which I have made of the skulls of the principal races of men, I would draw the following conclusions: First, that the average cranial capacity, and consequently the volume and weight of the brain, are markedly higher in the civilised European than in the savage races; second, that the range of variation is greater in the former than in the latter; third, that in uncivilised man the proportion of male crania having a capacity equal to the European mean, 1500 c.c., is extremely small; fourth, that though the capacity of the men's skulls is greater than that of the women's, there is not quite the same amount of difference between the sexes in a savage as in a civilised race.

It may now be of interest to say a few words on the capacity of the cranium in the large Anthropoid apes. I have measured, by the method already referred to, the capacity of the skulls of five adult male Gorillas, and obtained a mean of 494 c.c., the maximum being 590 c.c. and the minimum 410 c.c., the range of variation being 180 c.c. Dr. Delisle found the old male Orang (Maurice),[1] which died a short time ago in the Jardin des Plantes, to have a capacity of 385 c.c., whilst the younger male (Max) had a capacity of 470 c.c.[2] The mean of eleven specimens measured by him was 408 c.c., which is somewhat less than the measurements of males recorded by M. Topinard and Dr. Vogt; but it should be stated that in some of Dr. Delisle's specimens the sex could not be properly discriminated, and possibly some of them may have been females. The cranial capacity of seven male Chimpanzees is stated by M. Topinard to be 421 c.c.

The determination of the mass and weight of the brain as expressed in ounces, and of the capacity of the cranial cavity as expressed in cubic centimetres, are only rough methods of comparing brain with brain, either as between different races of men, or as between men and other mammals. Much finer methods are needed in order to obtain a more exact comparison.

The school of Phrenologists represented in the first half of the century by Gall, Spurzheim, and George Combe, whilst recognising the importance of the size of the brain as a measure of intellectual activity, also attached value to what was called its quality. At that time the inner mechanism of the brain was almost unknown, for the methods had not been discovered by which its minute structure could be determined. It is true that a difference was acknowledged, between the cortical grey matter situated on the surface of the hemispheres and the subjacent white matter. Spurzheim had also succeeded in determining the presence of fibres in the white matter of the encephalon, and had, to a slight extent, traced their path. The difference between the smooth surface of the hemispheres of the lower mammals and the convoluted surface of the brain of man and the higher mammals, and the influence which the development of the convolutions exercised in increasing the area of the cortical grey matter, were also known.

A most important step in advance was made, when, through the investigations of Leuret and Gratiolet, it became clear that the convolutions of the cerebrum, in their mode of arrangement, were not uniform in the orders of mammals which possessed convoluted brains, but that different patterns existed in the orders examined. By his further researches Gratiolet determined that in the Anthropoid apes, notwithstanding their much smaller brains, the same general plan of arrangement existed as in man, though differences occurred in many of the details, and that the key to unlock the complex arrangements in man was to be obtained by the study of the simpler disposition in the apes. These researches have enabled anatomists to localise the convolutions and the fissures which separate them from each other, and to apply to them precise descriptive terms. These investigations were necessarily preliminary to the histological study of the convolutions, and to experimental inquiry into their functions.

By the employment of the refined histological methods now in use, it has been shown that the grey matter in the cortex of the hemispheres, and in other parts of the brain, is the seat of enormous numbers of nerve-cells, and that those in the cortex, whilst possessing a characteristic pyramidal shape, present many variations in size. Further, that these nerve-cells give origin to nerve axial fibres, through which areas in the cortex become connected directly or indirectly, either with other areas in the same hemisphere, with parts of the brain and spinal cord situated below the cerebrum, with the muscular system, or with the skin and other organs of sense.

Every nerve-cell, with the nerve axial fibre arising from and belonging to it, is now called a Neurone, and both brain and spinal cord are built of tens of thousands of such neurones. It may reasonably be assumed that the larger the brain the more numerous are the neurones which enter into its constitution. The greater the number of the neurones, and the more complete the connections which the several areas have with each other through their axial fibres, the more complex becomes the internal mechanism, and the more perfect the structure of the organ. We may reasonably assume that this perfection of structure finds its highest manifestations in the brain of civilised men.

The specialisation in the relations and connections of the axial fibre processes of the neurones, at their termination in particular localities, obviously points to functional differences in the cortical and other areas, to which these processes extend. It has now been experimentally demonstrated that the cortex of the cerebrum is not, as M. Flourens conceived, of the same physiological value throughout; but that particular functions are localised in definite areas and convolutions In speaking of localisation of function in the cerebrum, one must not be understood as adopting the theory of Gall, that the mental faculties were definite in their number, that each had its seat in a particular region of the cortex, and that the locus of this region was marked on the surface of the skull and head by a more or less prominent "bump."

The foundation of a scientific basis for localisation dates from 1870, when Fritsch and Hitzig announced that definite movements followed the application of electrical stimulation to definite areas of the cortex in dogs. The indication thus given was at once seized upon by David Ferrier, who explored not only the hemispheres of dogs, but those of monkeys and other vertebrates.[1] By his researches and those of many subsequent inquirers, of whom amongst our own countrymen we may especially name Beevor, Horsley, and Schäfer, it has now been established that, when the convolutions bounding, and in close proximity to the fissure of Rolando are stimulated, motor reactions in the limbs, trunk, head and face follow, which have a definite purposive character, corresponding with the volitional movements of the animal. The Rolandic region is therefore regarded as a part of the motor apparatus; it is called the motor area, and the function of exciting voluntary movements is localised in its cortical grey matter.

By the researches of the same and other inquirers it has been determined that certain other convolutions are related to the different forms of sensibility, and are sensory or perceptive centres, localised for sight, hearing, taste, smell, and touch.

Most important observations on the paths of conduction of sensory impressions in the cortex of the convolutions were announced last year by Dr. Flechsig,[2] of Leipzig, so well known by his researches on the development of the tracts of nerve-fibres in the columns of the spinal cord, published several years ago. He discovered that the nerve-fibres in the cord did not become myelinated, *i.e.* attain their perfect structure, at a

1 "Nouvelles Archives du Muséum d'Histoire naturelle," 1895.
2 The stature of Maurice was 1 m 40; that of Max 1 m. 28.

1 "West Riding Asylum Reports," 1873.
2 "Die localisation der Geistigen Vorgänge," Leipzig, 1896.

uniform period of time, so that some acquired their complete functional importance before others. He has now applied the same method of research to the study of the development of the human brain, and has shown that in it also there is a difference in the time of attaining perfect structural development of the nerve-tracts. Further, he has discovered that the nerve-fibres in the cerebrum become myelinated, subsequent to the fibres of the other divisions of the cerebro-spinal nervous axis. When a child is born, very few of the fibres of its cerebrum are myelinated, and we have now an anatomical explanation of the reason why an infant has so inactive a brain and is so helpless a creature. It will therefore be of especial interest to determine, whether in those animals which are active as soon as they are born, and which can at once assume the characteristic attitude of the species, the fibres of the cerebrum are completely developed at the time of birth. Flechsig has also shown that the sensory paths myelinate before the motor tracts; that the paths of transmission of touch, and the other impulses conducted by the dorsal roots of the spinal nerves, are the first to become completely formed, whilst the fibres for auditory impulses are the last.

Flechsig names the great sensory centre which receives the impulses associated with touch, pain, temperature, muscular sense, &c., *Körperfühlsphäre*, the region of general-body-sensation, or the somæsthetic area, as translated by Dr. Barker.[1] The tracts conducting these impulses myelinate at successive periods after birth. They pass upwards from the inner and outer capsules and the optic thalamus as three systems.[2] Some enter the central convolutions of the Rolandic area, others reach the paracentral lobule, the inferior frontal convolution, the insula, and small parts of the middle and superior frontal convolutions; whilst considerable numbers reach the gyrus fornicatus and the hippocampal gyrus, which Ferrier had previously localised as a centre of common or tactile sensibility.

The Rolandic area, therefore, is not exclusively a motor area, but is a centre associated also with the general sensibility of the body. The motor fibres in it are not myelinated until after the sensory paths have become developed. As the motor paths become structurally complete, they can be traced downwards as the great pyramidal tract from the pyramidal nerve-cells in this area, from which they arise, into the spinal cord, where they come into close relation with the nerve-cells in the anterior horn of grey matter, from which the nerve axial fibres proceed that are distributed to the voluntary muscles.

Flechsig's observations agree with those of previous observers in placing the visual centre in the occipital lobe; the auditory centre in and near the superior temporal convolution; and the olfactory centre in the uncinate and hippocampal convolutions. Of the position of the taste centre he does not speak definitely, although he thinks it to be in proximity either to the centre of general sensation, or to the olfactory centre.

The centres of special sense in the cortex, and the large Rolandic area, which is the centre both for motion and general sensation, do not collectively occupy so much as one-half of the superficial area of the convolutions of the cortex. In all the lobes of the brain—frontal, parietal, occipito-temporal, and insula—convolutions are situated, not directly associated with the reception of sensory impressions, or as centres of motor activity, the function of which is to be otherwise accounted for. These convolutions lie intermediary to the sensory and motor centres. Flechsig has shown that in them myelination of the nerve-fibres does not take place until some weeks after birth, so that they are distinctly later in acquiring their structural perfection and functional activity. As the nerve-fibres become differentiated, they are seen to pass from the sense-centres into these intermediate convolutions, so as to connect adjacent centres together, and bring them into association with each other.[3] Hence he has called them the association centres, the function of which is to connect together centres and convolutions otherwise disconnected.[1]

[1] *Johns Hopkins Bulletin*, No. 70, January 1897.

[2] Drs. Ferrier and Aldren Turner communicated to the Royal Society of London a few weeks ago (*Proc. Roy Soc.*, June 17, 1897) an account of an elaborate research on the tracts which convey general and special sensibility to the cerebral cortex of monkeys. Their results were obtained by the aid of destructive lesions and the study of the consecutive degenerations in the nerve-tracts. From the brief abstract in the *Proceedings*, their research, though conducted by a different method, harmonises with the observations of Flechsig on the human brain, in regard to the course and connections of the great thalamic cortico-petal sensory fibres. They have also traced association fibres in connection with both the visual and auditory systems.

[3] The term association fibres was introduced a number of years ago to express fibres of the cerebrum which connect together parts of the cortex in the same hemisphere. Flechsig's fibres belong to this system.

We have now, therefore, direct anatomical evidence, based upon differences in their stages of development, that, in addition to the sensory and motor areas in the cortex of the human brain, a third division—the association centres—is to be distinguished.

If we compare the cerebrum in man and the apes, we find those convolutions which constitute the motor and sensory centres distinctly marked in both. An ape, like a man, can see, hear, taste, smell and touch; it also exhibits great muscular activity and variety of movement. It possesses, therefore, similar fundamental centres of sensation and motion, which are situated in areas of the cortex, resembling in arrangement and relative position, though much smaller in size than, the corresponding convolutions in the adult human brain. It is not unlikely, though the subject needs additional research, that the minute structure of these centres resembles that of man, though, from the comparatively restricted area of grey matter in the ape, the neurones will necessarily be much fewer in number.

In the cerebrum of a new-born infant, whilst the motor and sensory convolutions are distinct, the convolutions for the association areas, though present, are comparatively simple, and do not possess as many windings as are to be seen in the brain of a Chimpanzee not more than three or four years old.

Again, if we compare the brain of the Bushwoman, miscalled the Hottentot Venus, figured by Gratiolet and by Bischoff, or the one studied by Mr. John Marshall, with that of the philosopher Gauss, figured by Rudolph Wagner, we also recognise the convolutions in which the motor and sensory areas are situated. In all these brains they have a comparative simplicity of form and arrangement which enables one readily to discriminate them. When we turn, however, to the association areas in the three tiers of convolutions in the frontal lobe, and in the parieto-occipital and occipito-temporal regions where the bridging or annectant convolutions are placed, we cannot fail to observe that in a highly-developed brain, like that of Gauss, the association convolutions have a complexity in arrangement, and an extent of cortical surface much more marked than in the Bushwoman, and to a still greater degree than in the ape. The naked-eye anatomy of the brain therefore obviously points to the conclusion that these association areas are of great physiological importance.

The problem which has now to be solved is the determination of their function. Prolonged investigation into the development and comparative histology of the brain will be necessary before we can reach a sound anatomical basis on which to found satisfactory conclusions. It will especially be necessary to study the successive periods of development of the nerve-fibre tracts in the cerebrum of apes and other mammals, as well as the magnitude and intimate structure of the association areas in relation to that of the motor and sensory areas in the same species.

Flechsig, however, has not hesitated to ascribe to the association centres functions of the highest order. He believes them to be parts of the cerebral cortex engaged in the manifestations of the higher intelligence, such as memory, judgment, and reflection; but in the present state of our knowledge such conclusions are of course quite speculative.

It is not unlikely, however, that the impulses which are conveyed by the intermediate nerve-tracts, either on the one hand, from the sense centres to the association centres, or on the other, from the association centres to the sensory and motor centres, are neither motor nor sensory impulses, but a form of nerve energy, determined by the terminal connections and contacts of the nerve-fibres. It is possible that the association centres, with the intermediate connecting tracts, may serve to harmonise and control the centres for the reception of sensory impressions that we translate into consciousness, with those which excite motor activity, so as to give to the brain a completeness and perfection of structural mechanism, which without them it could not have possessed.

We know that an animal is guided by its instincts, through which it provides for its individual wants, and fulfils its place in nature. In man, on the other hand, the instinctive acts are under the influence of the reason and intelligence, and it is

[1] The association centres had previously been referred to by other observers as "silent portions" of the cortex, not responding to electrical stimulus. Their possible function had been discussed by Prof. Calderwood in "Relations of Mind and Brain," 2nd edit., 1884.

possible that the association centres, with the intermediate association fibres which connect them with the sensory and motor centres, may be the mechanism through which man is enabled to control his animal instincts, so far as they are dependent on motion and sensation.

The higher we ascend in the scale of humanity, the more perfect does this control become, and the more do the instincts, emotions, passions and appetites become subordinated to the self-conscious principle which regulates our judgments and beliefs. It will therefore now be a matter for scientific inquiry to determine, as far as the anatomical conditions will permit, the proportion which the association centres bear to the other centres both in mammals and in man, the period of development of the association fibres, in comparison with that of the motor and sensory fibres in different animals, and, if possible, to obtain a comparison in these respects between the brains of savages and those of men of a high order of intelligence.

The capability of erecting the trunk; the power of extending and fixing the hip and knee joints when standing; the stability of the foot; the range and variety of movement of the joints of the upper limb; the balancing of the head on the summit of the spine; the mass and weight of the brain, and the perfection of its internal mechanism, are distinctly human characters. They are the factors concerned in adapting the body of man, under the guidance of reason, intelligence, the sense of responsibility and power of self-control, for the discharge of varied and important duties in relation to himself, his Maker, his fellows, the animal world and the earth on which he lives.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. MICHAEL FOSTER, M.A., M.D., D.C.L., LL.D., SEC.R.S., PRESIDENT OF THE SECTION.

WE who have come from the little island on the other side of the great waters to take part in this important gathering of the British Association, have of late been much exercised in retrospection. We have been looking back on the sixty years reign of our beloved Sovereign, and dwelling on what has happened during her gracious rule. We have, perhaps, done little in calling to mind the wrongs, the mistakes and the failures of the Victorian era; but our minds and our mouths have been full of its achievements and its progress; and each of us, of himself or through another, has been busy in bringing back to the present the events of more than half a century of the past. It was while I, with others, was in this retrospective mood that the duty of preparing some few words to say to you to-day seemed suddenly to change from an impalpable cloud in the far distance to a heavy burden pressing directly on the back; and in choosing something to say I have succumbed to the dominant influence. Before putting pen to paper, however, I recovered sufficiently to resist the temptation to add one more to the many reviews which have appeared of the progress of physiology during the Victorian era. I also rejected the idea of doing that for which I find precedents in past presidential addresses—namely, of attempting to tell what has been the history of the science to which a Section is devoted during the brief interval which has elapsed since the Section last met; to try and catch physiology, or any other science, as it rushes through the brief period of some twelve months seemed to me not unlike photographing the flying bullet without adequate apparatus; the result could only be either a blurred or a delusive image. But I bethought me that this is not the first, we hope it will not be the last, time that the British Association has met in the Western Hemisphere; and though the events of the thirteen years which have slipped by since the meeting at Montreal in 1884 might seem to furnish a very slender oat on which to pipe a presidential address, I have hoped that I might be led to sound upon it some few notes which might be listened to.

And indeed, though perhaps when we come to look into it closely almost every period would seem to have a value of its own, the past thirteen years do, in a certain sense, mark a break between the physiology of the past and that of the future. When the Association met at Montreal in 1884, Darwin, whose pregnant ideas have swayed physiology in the limited sense of that word, as well as that broader study of living beings which we sometimes call biology, as indeed they have every branch of natural knowledge, had been taken from us only some two years before, and there were still alive most of the men who did the great works of physiology of the middle and latter half of this century. The gifted Claude Bernard had passed away some years before, but his peers might have been present at Montreal. Bowman, whose classic works on muscle and kidney stand out as peaks in the physiological landscape of the past, models of researches finished and complete so far as the opportunities of the time would allow, fruitful beginnings and admirable guides for the labours of others. Brown-Sequard, who shares with Bernard the glory of having opened up the great modern path of the influence of the nervous system on vascular and thus on nutritional events, and who, if he made some mistakes, did many things which will last for all time. Brücke, whose clear judgment, as shown in his digestive and other work, gave permanent value to whatever he put forth. Du Bois Reymond, who, if he laboured in a narrow path, set a brilliant example of the way in which exact physical analysis may be applied to the phenomena of living beings, and in other ways had a powerful influence on the progress of physiology. Donders, whose mind seemed to have caught something of the better qualities of the physiological organ to which his professional life was devoted, and our knowledge of which he so largely extended, so sharply did he focus his mental eye on every physiological problem to which he turned—and these were many and varied. Helmholtz, whose great works on vision and hearing, to say nothing of his earlier distinctly physiological researches, make us feel that if physics gained much, physiology lost even more when the physiologist turned aside to more distinctly physical inquiries. Lastly, and not least, Ludwig, who by his own hands or through his pupils did so much to make physiology the exact science which it is to-day, but which it was not when he began his work. I say lastly, but I might add the name of one who, though barred by circumstances from contributing much directly to physiology by way of research, so used his powerful influence in many ways in aid of physiological interests as to have helped the science onward to no mean extent, at least among English-speaking people—I mean Huxley. All these might have met at Montreal. They have all left us now. Among the peers of the men I have mentioned whose chief labours were carried on in the forties, the fifties and the sixties of the century, one prominent inquirer alone seems to be left, Albert von Kölliker, who in his old age is doing work of which even he in his youth might have been proud. The thirteen years which have swept the others away seem to mark a gulf between the physiological world of to-day and that of the time in which most of their work was done.

They are gone, but they have left behind their work and their names. May they of the future, as I believe we of the present are doing, take up their work and their example, doing work other than theirs but after their pattern, following in their steps.

In the thirteen years during which these have passed away physiology has not been idle. Indeed, the more we look into the period the more it seems to contain.

The study of physiology, as of other sciences, though it may be stimulated by difficulties (and physiology has the stimulus of a special form of opposition unknown to other sciences), expands under the sunshine of opportunity and aid. And it may be worth while to compare the opportunities for study of physiology in 1884 with those in 1897. At this meeting of the British Association I may fitly confine myself, I was going to say, to British matters; but I feel at this point, as others have felt, the want of a suitable nomenclature. We who are gathered here to-day have, with the exception of a few honoured guests from the Eastern Hemisphere, one common bond, one common token of unity, and, so far as I know, one only; I am speaking now of outward tokens; down deeper in our nature there are, I trust, yet others. We all speak the English tongue. Some of us belong to what is called Great Britain and Ireland, others to that which is sometimes spoken of as Greater Britain. But there are others here who belong to neither; though English in tongue, they are in no sense British. To myself, to whom the being English in speech is a fact of far deeper moment than any political boundary, and who wish at the present moment to deal with the study of physiology among all those who speak the English tongue, there comes the great want of some word which will denote all such. I hope, indeed I think, that others feel the same want too. The term Anglo-Saxon is at once pedantic and incorrect, and yet there is none other; and, in the absence of such a better term, I shall be forgiven if I venture at times to use the

seemingly narrow word English as really meaning something much broader than British in its very broadest sense.

Using English in this sense, I may, I think, venture to say that the thirteen years which separate 1884 from to-day have witnessed among English people a development of opportunities for physiological study such as no other like period has seen. It is not without significance that only a year or two previous to this period, in England proper, in little England, neither of the ancient Universities of Oxford and Cambridge, which, historically at least, represent the fullest academical aspirations of the nation, possessed a chair of physiology; the present professors, who are the first, were both appointed in 1883. Up to that time the science of physiology had not been deemed worthy, by either university, of a distinctive professorial mechanism. The act of these ancient institutions was only a manifestation of modern impulses, shared also by the metropolis and by the provinces at large. Whereas up to that time the posts for teaching physiology, by whatever name they were called, had been in most cases held by men whose intellectual loins were girded for other purposes than physiology, and who used the posts as stepping-stones for what they considered better things, since that time, as each post became vacant, it has almost invariably been filled by men wishing and purposing at least to devote their whole energies to the science. Scotland, in many respects the forerunner of England in intellectual matters, had not so much need of change; but she, too, has moved in the same direction, as has also the sister island.

And if we turn to this Western Continent, we find in Canada and in the States the same notable enlargement of physiological opportunity, or even a still more notable one. If the English-speaking physiologist dots on the map each place on this Western Hemisphere which is an academic focus of his science, he may well be proud of the opportunities now afforded for the development of English physiology; and the greater part of this has come within the last thirteen years.

Professorial chairs or their analogues are, however, after all but a small part of the provision for the development of physiological science. The heart of physiology is the laboratory. It is this which sends the life-blood through the frame; and in respect to this, perhaps, more than to anything else, has the progress of the past thirteen years been striking. Doubtless, on both sides of the waters there were physiological laboratories, and good ones, in 1884; but how much have even these during that period been enlarged and improved, and how many new ones have been added? In how many places, even right up to about 1884, the professor or lecturer was fain to be content with mere lecture experiments and a simple course of histology, with perhaps a few chemical exercises for his students! Now each teacher, however modest his post, feels and says that the authorities under whom he works are bound to provide him with the means of leading his students along the only path by which the science can be truly entered upon, that by which each learner repeats for himself the fundamental observations on which the science is based.

But there is a still larger outcome from the professorial chair and the physiological laboratory than the training of the student; these are opportunities not for teaching only, but also for research. And perhaps in no respect has the development during the past thirteen years been so marked as in this. Never so clearly as during this period has it become recognised that each post for teaching is no less a post for learning, that among academic duties the making knowledge is as urgent as the distributing it, and that among professorial qualifications the gift of garnering in new truths is at least as needful as facility in the didactic exposition of old ones. Thirteen years has seen a great change in this matter, and the progress has been perhaps greater on this side of the water than on the other, so far as English-speaking people are concerned. We on the other side have witnessed with envy the establishment on this side of a university, physiology having in it an honoured place, the keynote of which is the development of original research. It will, I ventur to think, be considered a strong confirmation of my present theme that the Clark University at Worcester was founded only ten years ago.

And here, as an English-speaking person, may I be allowed to point out, not without pride, that these thirteen years of increased opportunity have been thirteen years of increased fruitfulness. In the history of our science, among the names of the great men who have made epochs, English names, from Harvey onwards, occupy no mean place; but the greatness of such great men is of no national birth; it comes as it lists, and is independent of time and of place. If we turn to the more every-day workers, whose continued labours more slowly build up the growing edifice and provide the needful nourishment for the greatness of which I have just spoken, we may, I will dare to say, affirm that the last thirteen years has brought contributions to physiology, made known in the English tongue, which, whether we regard their quantity or their quality, significantly outdo the like contributions made in any foregoing period of the same length. Those contributions have been equally as numerous, equally as good on this side as on the other side of the waters. And here I trust I shall be pardoned if personal ties and affection lead me to throw in a personal word. May I not say that much which has been done on this side has been directly or indirectly the outcome of the energy and gifts of one whom I may fitly name on an occasion such as this, since, though he belonged to the other side, his physiological life was passed and his work was done on this side, one who has been taken from us since this Association last met, Henry Newell Martin?

Yes, during these thirteen years, if we put aside the loss of comrades, physiology has been prosperous with us and the outlook is bright; but, as every cloud has its silver lining, so shadow follows all sunshine, success brings danger, and something bitter rises up amid the sweet of prosperity. The development of which I have spoken is an outcome of the progressive activity of the age, and the dominant note of that activity is heard in the word "commercial." Noblemen and noblewomen open shop, and every one, low as well as high, presses forward towards large or quick profits. The very influences which have made devotion to scientific inquiry a possible means of livelihood, and so fostered scientific investigation, are creating a new danger. The path of the professor was in old times narrow and straight, and only the few who had a real call cared to tread it; nowadays there is some fear lest it become so broad and so easy as to tempt those who are in no way fitted for it. There is an increasing risk of men undertaking a research, not because a question is crying out to them to be answered, but in the hope that the publication of their results may win for them a lucrative post. There is, moreover, an even greater evil ahead. The man who lights on a new scientific method holds the key of a chamber in which much gold may be stored up; and strong is the temptation for him to keep the new knowledge to himself until he has filled his fill, while all the time his brother-inquirers are wandering about in the dark through lack of that which he possesses. Such a selfish withholding of new scientific truth is beginning to be not rare in some branches of knowledge. May it never come near us!

Now I will, with your permission, cease to sound the provincial note, and ask your attention for a few minutes while I attempt to dwell on what seem to me to be some of the salient features of the fruits of physiological activity, not among English-speaking people only, but among all folk, during the past thirteen years.

When we review the records of research and discovery over any lengthened period, we find that in every branch of the study progress is irregular, that it ebbs and flows. At one time a particular problem occupies much attention, the periodicals are full of memoirs about it, and many of the young bloods flesh their maiden swords upon it. Then again for awhile it seems to lie dormant and unheeded. But quite irrespective of this feature, which seems to belong to all lines of inquiry, we may recognise two kinds of progress. On the one hand, in such a period, in spite of the waves just mentioned, a steady advance continually goes on in researches which were begun and pushed forward in former periods, some of them being of very old date. On the other hand, new lines of investigation, starting with quite new ideas or rendered possible by the introduction of new methods, are or may be begun. Such naturally attract great attention, and give a special character to the period.

In the past thirteen years we may recognise both these kinds of progress. Of the former kind I might take, as an example, the time-honoured problems of the mechanics of the circulation. In spite of the labour which has been spent on these in times of old, something always remains to be done, and the last thirteen years have not been idle. The researches of Hürthle and Tigerstedt, of Roy and Adami, not to mention others, have left us wiser than we were before. So again, with the also old problems of muscular contraction, progress, if not exciting, has been real; we are some steps measurably nearer an understand-

ing what is the exact nature of the fundamental changes which bring about contraction and what are the relations of those changes to the structure of muscular fibre. In respect to another old problem, too, the beat of the heart, we have continued to creep nearer and nearer to the full light. Problems again, the method of attacking which is of more recent origin, such as the nature of secretion, and the allied problem of the nature of transudation, have engaged attention and brought about that stirring of the waters of controversy which, whatever be its effects in other departments of life, is never in science wholly a waste of time, if indeed it be a waste of time at all, since, in matters of science, the tribunal to which the combatants of both sides appeal is always sure to give a true judgment in the end. In the controversy thus arisen, the last word has perhaps not yet been said, but whether we tend at present to side with Heidenhain, who has continued into the past thirteen years the brilliant labours which were perhaps the distinguishing features of physiological progress in preceding periods, and who in his present sufferings carries with him, I am sure, the sympathies if not the hopes of all his brethren, or whether we are more inclined to join those who hold different views, we may all agree in saying that we have, in 1897, distinctly clearer ideas of why secretion gathers in an alveolus or lymph in a lymph space than we had in 1884.

I might multiply such examples of progress on more or less old lines until I wearied you; but I will try not to do so. I wish rather to dwell for a few minutes on some of what seem to be the salient new features of the period under review.

One such feature is, I venture to think, the development of what may perhaps be called the new physiological chemistry. We always are, and for a long time always have been, learning something new about the chemical phenomena of living beings. During the years preceding those immediately recent, great progress, for which we have especially, perhaps, to thank Kühne, was made in our knowledge of the bodies which we speak of as proteids and their allies. But while admitting to the full the high value of all these researches, and the great light which they threw on many of the obscurer problems of the chemical changes of the body, such, for instance, as the digestive changes and the clotting of blood, it could not but be felt that their range was restricted and their value limited. Granting the extreme usefulness of being able to distinguish bodies through their solution or precipitation by means of this or that salt or acid, this did not seem to promise to throw much light on the all important problem as to what was the connection between the chemical constitution of such bodies and their work in the economy of a living being. For it need not be argued that this is an all-important problem. To-day, as yesterday and as in the days before, the mention of the word vitalism or its equivalent separates as a war-cry physiologists into two camps, one contending that all the phenomena of life can, and the other that they cannot, be explained as the result of the action of chemico-physical forces. For myself, I have always felt that while such a controversy, like other controversies as I ventured to say just now, is useful as a stirring of the waters, through which much oxygen is brought home to many things and no little purification effected, the time for the final judgment on the question will not come until we shall more clearly understand than we do at present what we mean by physical and chemical, and may perhaps be put off until somewhere near the end of all things, when we shall know as fully as we ever shall what the forces to which we give these names can do and what they cannot. Meanwhile the great thing is to push forward, so far as may be, the chemical analysis of the phenomena presented by living beings. Hitherto the physiological chemists, or the chemical physiologists as perhaps they ought rather to be called, have perhaps gone too much their own gait, and have seemed to be constructing too much a kind of chemistry of their own. But that, may I say, has in part been so because they did not receive from their distinctly chemical brethren the help of which they were in need. May I go so far as to say that to us physiologists these our brethren seemed to be lagging somewhat behind, at least along those lines of their science which directly told on our inquiries? That is, however, no longer the case. They are producing work and giving us ideas which we can carry straight into physiological problems. The remarkable work of Emil Fischer on sugars, one of the bright results of my period of thirteen years, may fully be regarded as opening up a new era in the physiology of the carbohydrates, opening up a new era because it has shown us the way how to investigate physiological problems on purely and distinctively chemical lines. Not in the carbohydrates only, but in all directions our younger investigators are treating the old problems by the new chemical methods; the old physiological chemistry is passing away; nowhere, perhaps, is the outlook more promising than in this direction; and we may at any time receive the news that the stubborn old fortress of the proteids has succumbed to the new attack.

Another marked feature of the period has been the increasing attention given to the study of the lower forms of life, using their simpler structures and more diffuse phenomena to elucidate the more general properties of living matter. During the greater part of the present century physiologists have, as a rule, chosen as subjects of their observations almost exclusively the vertebrata; by far the larger part of the results obtained during this time have been gained by inquiries restricted to some half a dozen kinds of backboned animals; the frog and the myograph, the dog and the kymograph have almost seemed the alpha and the omega of the science. This has been made a reproach by some, but, I cannot help thinking, unjustly. Physiology is, in its broad meaning, the unravelling of the potentialities of things in the condition which we call living. In the higher animals the evolution by differentiation has brought these potentialities, so to speak, near the surface, or even laid them bare as actual properties capable of being grasped. In the lower animals they still lie deep buried in primeval sameness; and we may grope among them in vain unless we have a clue furnished by the study of the higher animal. This truth seems to have been early recognised during the progress of the science. In the old time, observers such as Spallanzani, with but a moderate amount of accumulated knowledge behind them, and a host of problems before them, with but few lines of inquiry as yet definitely laid down, were free to choose the subjects of their investigation where they pleased, and in the wide field open to them prodded, so to speak, among all living things, indifferent whether they possessed a backbone or no. But it soon became obvious that the study of the special problems of the more highly organised creature was more fruitful, or at least more easily fruitful, than that of the general problems of the simpler forms; and hence it came about that inquiry, as it went on, grew more and more limited to the former. But an increasing knowledge of the laws of life as exemplified in the differentiated phenomena of the mammal is increasingly fitting us for a successful attack on the more general phenomena of the lowly creatures possessing little more than that molecular organisation, if such a phrase be permitted, which alone supplies the conditions for the manifestation of vital activities. And, though it may be true that in all periods men have from time to time laboured at this theme, I think that I am not wrong in saying that the last dozen years or so mark a distinct departure both as regards the number of researches directed to it, and also, what is of greater moment, as regards the definiteness and clearness of the results thereby obtained. One has only to look at the results recorded in the valuable treatises of Verworn and Biedermann, whether obtained by the authors themselves or by others, to feel great hope that in the immediately near future a notable advance will be made in our grasp of the nature of that varying collection of molecular conditions, potencies and changes, slimy hitherto to the intellectual no less than to the physical touch, which we are in the habit of denoting by the more or less magical word protoplasm. And perhaps one happy feature of such an advance will be one step in the way of that reintegration which men of science fondly hope may ultimately follow the differentiation of studies now so fierce and attended by many ills; in the problems of protoplasm the animal physiologist touches hands with the botanist, and both find that under different names they are striving towards the same end.

Closely allied to and indeed a part of the above line of inquiry is the study of the physiological attributes of the cell and of their connection with its intrinsic organisation. This is a study which, during the last dozen years, has borne no mean fruits; but it is an old study, one which has been worked at from time to time, reviving again and again as new methods offered new opportunities. Moreover, it will probably come directly before us in our sectional work, and therefore I will say nothing more of it here.

Still another striking feature of the past dozen years has been the advance of our knowledge in regard to those events of the animal body which we have now learnt to speak of as "internal secretion." This knowledge did not begin in this period. The

first note was sounded long ago in the middle of the century, when Claude Bernard made known what he called "the glycogenic function of the liver." Men, too, were busy with the thyroid body and the suprarenal capsules long before the meeting of the British Association at Montreal. But it was since then, namely in 1889, that Minkowski published his discovery of the diabetic phenomena resulting from the total removal of the pancreas. That, I venture to think, was of momentous value, not only as a valuable discovery in itself, but especially, perhaps, in confirming and fixing our ideas as to internal secretion, and in encouraging further research.

Minkowski's investigation possessed this notable feature, that it was clear, sharp and decided, and, moreover, the chief factor, namely sugar, was subject to quantitative methods. The results of removing the thyroid body had been to a large extent general, often vague, and in some cases uncertain; so much so as to justify, to a certain extent, the doubts held by some as to the validity of the conclusion that the symptoms witnessed were really and simply due to the absence of the organ removed. The observer who removes the pancreas has to deal with a tangible and measurable result, the appearance of sugar in the urine. About this there can be no mistake, no uncertainty. And the confidence thus engendered in the conclusion that the pancreas, besides secreting the pancreatic juice, effects some notable change in the blood passing through it, spread to the analogous conclusions concerning the thyroid and the suprarenal, and moreover suggested further experimental inquiry. By those inquiries all previous doubts have been removed; it is not now a question whether or no the thyroid carries on a so-called internal secretion; the problem is reduced to finding out what it exactly does and how exactly it does it. Moreover, no one can at the present day suppose that this feature of internal secretion is confined to the thyroid, the suprarenal, and the pancreas; it needs no spirit of prophecy to foretell that the coming years will add to physiological science a large and long chapter, the first marked distinctive verses of which belong to the dozen years which have just passed away.

The above three lines of advance are of themselves enough to justify a certain pride on the part of the physiologist as to the share which his science is taking in the forward movements of the time. And yet I venture to think that each and all of these is wholly overshadowed by researches of another kind, through which knowledge has made, during the past dozen years or so, a bound so momentous and so far-reaching that all other results gathered in during the time seem to shrink into relative insignificance.

It was a little before my period, in the year 1879, that Golgi published his modest note, "Un nuovo processo di technica microscopica" ("Rendiconti del reale Istituto Lombardo," vol. xii. p. 206). That was the breaking out from the rocks of a little stream which has since swollen into a great flood. It is quite true that long before a new era in our knowledge of the central nervous system had been opened up by the works of Ferrier and of Fritsch and Hitzig. Between 1870 and 1880 progress in this branch of physiology had been continued and rapid. Yet that progress had left much to be desired. On the one hand the experimental inquiries, even when they were carried out with the safeguard of an adequate psychical analysis of the phenomena which presented themselves, and this was not always the case, sounded a very uncertain note, at least when they dealt with other than simply motor effects. They were, moreover, not unfrequently in discord with clinical experience. In general the conclusions which were arrived at through them, save such as were based on the production of easily recognised and often measurable movements, were regarded by many as conclusions of the kind which could not be ignored, which demanded respectful attention, and yet which failed to carry conviction. It seemed to be risking too much to trust too implicitly to the apparent teaching of the results arrived at; something appeared wanting to give these their full validity, to explain their full and certain meaning by showing their connection with what was known in other ways and by other methods. On the other hand, during nearly all this time, in spite of the valuable results acquired by the continually improving histological technique, by the degeneration method, and by the developmental method, by the study of the periods of myelination, most of us, at all events, were sitting down, as our forefathers had done, before the intricate maze of encephalic structure, fascinated by its complexity, but wondering what it all meant. Even when we attempted to thread our way through the relatively simple tangle of the spinal cord, to expect that we should ever see our way so to unravel out the strands of fibres, here thick, there thin, now twisting and turning, and anon running straight, or so to set out in definite constellations the seeming milky way of star-like cells, so to do this as to make the conformation of the cord explain the performances of which it is capable, appeared to be something beyond our reach. And when we passed from the cord to those cerebral structures the even gross topography of which is the despair of the beginner in anatomical studies, the multiple maze of grey and white matter seemed to frame itself into the letters graven on the gateway of the city of Dis, and bid us leave all hope behind.

What a change has come upon us during the past dozen years, and how great is the hope of ultimate success which we have to-day. Into what at the meeting at Montreal seemed a cloudy mass, in which most things were indistinct and doubtful, and into which each man could read images of possible mechanisms according as his fancy led, the method of Golgi has fallen like a clarifying drop, and at the present moment we are watching with interest and delight how that vague cloud is beginning to clear up and develop into a sharp and definite picture, in which lines objectively distinct and saying one thing only reveal themselves more and more. This is not the place to enter into details, and I will content myself with pointing out as illustrative of my theme the progress which is being made in our knowledge of how we hear and how sounds affect us. A dozen years ago we possessed experimental and clinical evidence which led us to believe that auditory impulses sweeping up the auditory nerve became developed into auditory sensations through events taking place in the temporo-sphenoidal convolution, and we had some indications that as these passed upward through the lower and middle brain the striæ acusticæ and the lateral fillet had some part to play. Beyond this we knew but little. To-day we can with confidence construct a diagram which he who runs can read, showing how the impulses undergoing a relay in the tuberculum acusticum and accessory nucleus pass by the striæ acusticæ and trapezoid fibres to the superior olive and trapezoid nucleus, and onwards by the lateral fillet to the posterior corpus quadrageminum and to the cortex of the temporo-sphenoidal convolution. And if much, very much, yet remains to be done even in tracking out yet more exactly the path pursued by the impulses while they are still undeveloped impulses, not as yet lit up with consciousness, and in understanding the functional meaning of relays and apparently alternate routes, to say nothing of the deeper problems of when and how the psychical element intervenes, we feel that we have in our hands the clue by means of which we may hope to trace out clearly the mechanisms by which, whether consciousness plays its part or no, sounds affect so profoundly and so diversely the movements of the body, and haply some time or other to tell, in a plain and exact way, the story of how we hear. I have thus referred to hearing because the problems connected with this seemed, thirteen years ago, so eminently obscure; it appeared so pre-eminently hard a task, that of tracing out the path of an auditory impulse through the confused maze of fibre and cell presented by the lower and middle brain. Of the mechanism of sight we seemed even then to have better knowledge, but how much more clearly do we, so to speak, see vision now? So also with all other sensations, even those most obscure ones of touch and pain; indeed, all over the nervous system light seems breaking in a most remarkable way.

This great and significant progress we owe, I venture to say, to Golgi, to the method introduced by him; and I for one cannot help being glad that this important contribution to science, as well as another contingent and most valuable one, the degeneration method of Marchi, should be among the many tokens that Italy, the mother of all sciences in times gone by, is now once more taking her right place in scientific no less than in political life. We owe, I say, this progress to Golgi in the sense that the method introduced by him was the beginning of the new researches. We owe, moreover, to Golgi not the mere technical introduction of the method, but something more. He himself pointed out the theoretical significance of the results which his method produced; and if in this he has been outstripped and even corrected by others, his original merit must not be allowed to be forgotten. Those others are many, in many lands; but two names stand out conspicuous among them. If rejuvenescent Italy invented the method, another ancient country, whose fame, once brilliant in the past, like that of Italy, suffered in later times an eclipse, produced the

man who, above all others, has showed us how to use it. At the meeting at Montreal a voice from Spain telling of things physiological would have seemed a voice crying out of the wilderness; to-day the name of Ramon-y-Cayal is in every physiologist's mouth. That is one name, but there is yet another. Years ago, when those of us who are now veterans and see signs that it is time for us to stand aside were spelling out the primer of histology, one name was always before us as that of a man who touched every tissue and touched each well. It is a consoling thought to some of us elder ones that histological research seems to be an antidote to senile decay. As the companion of the young Spaniard in the pregnant work on the histology of the central nervous system done in the eighties and the nineties of the century, must be named the name of the man who was brilliant in the fifties, Albert von Kölliker.

When I say that the progress of our knowledge of the central nervous system during the past thirteen years has been largely due to the application of the method of Golgi, I do not mean that it, alone and by itself, has done what has been done. That is not the way of science. Almost every thrust forward in science is a resultant of concurrent forces working along different lines; and in most cases at least significant progress comes when efforts from different quarters meet and join hands. And especially as regards methods it is true that their value and effect depend on their coming at their allotted times. As I said above, neither experimental investigation nor clinical observation nor histological inquiry by the then known methods, had been idle before 1880. They had moreover borne even notable fruits, but one thing was lacking for their fuller fruition. The experimental and clinical results all postulated the existence of clear definite paths for impulses within the central nervous system, of paths moreover which, while clear and sharp, were manifold and, under certain conditions, alternate or even vicarious, and were so constructed that the impulses as they swept along them underwent from time to time—that is, at some place or other transformations or at least changes in nature. But the methods of histological investigations available before that of Golgi, though they taught us much, failed to furnish such an analysis of the tangle of grey and white matter as would clearly indicate the paths required. This the method of Golgi did, or rather is doing. Where gold failed silver has succeeded, and is succeeding. Thanks to the black tract which silver when handled in a certain way leaves behind it in the animal body, as indeed it does elsewhere, we can now trace out, within the central nervous system, the pathway afforded by the nerve cell and the nerve cell alone. We see its dendrites branching out in various directions, each alert to dance the molecular dance assigned to it at once by the more lasting conditions which we call structural, and the more passing ones which we call functional, so soon as some partner touch its hand. We see the body of the cell with its dominant nucleus ready to obey and yet to marshal and command the figure so started. We see the neuraxon prepared to carry that figure along itself, it may be to far-distant parts, it may be to near ones, or to divert it along collaterals, it may be many, or it may be few, or to spread out at once among numerous seemingly equipollent branches. And whether it prove ultimately true or no that the figure of the dancing molecules sweeps always onwards along the dendrites towards the nucleus, and always outwards away from the nucleus along the neuraxon, or whatever way in the end be shown to be the exact differences in nature and action between the dendrites and the neuraxon, this at least seems sure, that cell plays upon cell only by such a kind of contact as seems to afford an opportunity for change in the figure of the dance, that is to say, in the nature of the impulse, and that in at least the ordinary play it is the terminal of the neuraxon (either of the main core or a collateral) of one cell which touches with a vibrating touch the dendrite or the body of some other cell. We can thus, I say, by the almost magic use of a silver token—I say magic use, for he who for the first time is shown a Golgi preparation is amazed to learn that it is such a sprawling thing as he sees before him which teaches so much, and yet when he comes to use it acquires daily increased confidence in its worth—it is by the use of such a silver token that we have been able to unravel so much of the intricate tangle of the possible paths of nervous impulses. By themselves, the acquisition of a set of pictures of such black lines would be of little value. But, and this I venture to think is the important point, to a most remarkable extent, and with noteworthy rapidity, the histological results thus arrived at, aided by analogous results reached by the degeneration method, especially by the newer method akin to that of Golgi, that of Marchi, have confirmed or at times extended and corrected the teachings of experimental investigation and clinical observation. It is this which gives strength to our present position; we are attacking our problems along two independent lines. On the one hand we are tracing out anatomical paths, and laying bare the joints of histological machinery; on the other hand, beginning with the phenomena, and analysing the manifestations of disorder, whether of our own making or no, as well as of order, we are striving to delineate the machinery by help of its action. When the results of the two methods coincide, we may be confident that we are on the road of all truth; when they disagree, the very disagreement serves as the starting-point for fresh inquiries along the one line or the other.

Fruitful as have been the labours of the past dozen years, we may rightly consider them as but the earnest of that which is to come; and those of us who are far down on the slope of life may wistfully look forward to the next meeting of the Association on these Western shores, wondering what marvels will then be told.

Physiology, even in the narrower sense to which, by emphasis on the wavering barrier which parts the animal from the plant, it is restricted in this Section, deals with many kinds of being, and with many things in each. But, somewhat as man, in one aspect a tiny fragment of the world, still more of the universe, in another aspect looms so great as to overshadow everything else, so the nervous system, seen from one point of view, is no more than a mere part of the whole organism, but, seen from another point of view, seems by its importance to swallow up all the rest. As man is apt to look upon all other things as mainly subserving his interests and purposes, so the physiologist, but with more justice, may regard all the rest of the body as mainly subserving the welfare of the nervous system; and, as man was created last, so our natural knowledge of the working of that nervous system has been the latest in its growth. But, if there be any truth in what I have urged to-day, we are witnessing a growth which promises to be as rapid as it has seemed to be delayed. Little spirit of prophecy is needed to foretell that in the not so distant future the teacher of physiology will hurry over the themes on which he now dwells so long, in order that he may have time to expound the most important of all the truths which he has to tell, those which have to do with the manifold workings of the brain.

And I will be here so bold as to dare to point out that this development of his science must, in the times to come, influence the attitude of the physiologist towards the world, and ought to influence the attitude of the world towards him. I imagine that if a plebiscite, limited even to instructed, I might almost say scientific, men, were taken at the present moment, it would be found that the most prevalent conception of physiology is that it is a something which is in some way an appendage to the art of medicine. That physiology is, and always must be, the basis of the science of healing, is so much a truism that I would not venture to repeat it here were it not that some of those enemies, alike to science and humanity, who are at times called anti-vivisectionists, and whose zeal often outruns, not only discretion, but even truth, have quite recently asserted that I think otherwise. Should such a hallucination ever threaten to possess me, I should only have to turn to the little we yet know of the physiology of the nervous system and remind myself how great a help the results of pure physiological curiosity—I repeat the words, pure physiological curiosity, for curiosity is the mother of science—have been, alike to the surgeon and the physician, in the treatment of those in some way most afflicting maladies, the diseases of the nervous system. No, physiology is, and always must be, the basis of the science of healing; but it is something more. When physiology is dealing with those parts of the body which we call muscular, vascular, glandular tissues and the like, rightly handled she points out the way not only to mend that which is hurt, to repair the damages of bad usage and disease, but so to train the growing tissues and to guide the grown ones as that the best use may be made of them for the purposes of life. She not only heals, she governs and educates. Nor does she do otherwise when she comes to deal with the nervous tissues. Nay, it is the very prerogative of these nervous tissues that their life is above that of all the other tissues, contingent on the environ-

ment and susceptible of education. If increasing knowledge gives us increasing power so to mould a muscular fibre that it shall play to the best the part which it has to play in life, the little knowledge we at present possess gives us at least much confidence in a coming far greater power over the nerve cell. This is not the place to plunge into the deep waters of the relation which the body bears to the mind; but this at least stares us in the face, that changes in what we call the body bring about changes in what we call the mind. When we alter the one, we alter the other. If, as the whole past history of our science leads us to expect, in the coming years a clearer and clearer insight into the nature and conditions of that molecular dance which is to us the material token of nervous action, and a fuller, exacter knowledge of the laws which govern the sweep of nervous impulses along fibre and cell, give us wider and directer command over the moulding of the growing nervous mechanism and the maintenance and regulation of the grown one, then assuredly physiology will take its place as a judge of appeal in questions not only of the body, but of the mind; it will raise its voice not in the hospital and consulting-room only, but also in the senate and the school.

One word more. We physiologists are sorely tempted towards self-righteousness, for we enjoy that blessedness which comes when men revile you and persecute you and say all manner of evil against you falsely. In the mother country our hands are tied by an Act which was defined by one of the highest legal authorities as a "penal" Act; and though with us, as with others, difficulties may have awakened activity, our science suffers from the action of the State. And some there are who would go still further than the State has gone, though that is far, who would take from us even that which we have, and bid us make bricks wholly without straw. To go back is always a hard thing, and we in England can hardly look to any great betterment for at least many years to come. But unless what I have ventured to put before you to-day be a mocking phantasm, unworthy of this great Association and this great occasion, England in this respect at least offers an example to be shunned alike by her offspring and her fellows.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. W. ERNEST THOMSON has been appointed to the chair of Physiology at Anderson's College, Glasgow, in succession to Dr. Campbell Black.

THE *Athenæum* states that Peoria, Illinois, is to have a university. A millionaire has endowed the proposed institution with 1,000,000 dollars, placing the estate in the hands of trustees to be named by himself. His instructions are that the estate shall be conserved until the interest accretions, together with the principal, amount to 1,500,000 dollars, when the buildings are to be erected, the faculty secured, and the library, laboratories, &c., equipped.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 25.—M. A. Chatin in the chair.—Persian truffles. Note by M. Chatin on a letter received from the late Dr. Tholozan.—The recent storms in France, July and August 1897, and the solar period, by M. Ch. V. Zenger. Further evidence in support of the author's theory of the parallelism of atmospheric, electric, magnetic and seismic disturbances, and their connection with the electro-dynamic action of the sun.—Summary of solar observations made at the Royal Observatory of the Roman College during the first half of the year 1897, by M. P. Tacchini.—Observations of the solar eclipse of July 29 at the observatory of Rio de Janeiro, by M. L. Cruls.—On the reduction of vectors and metric properties, by M. J. Andrade.—Critical constants of some gases, by MM. A. Leduc and P. Sacerdote. The authors have determined the temperature and pressure, at the critical point, of hydrogen sulphide, chloride and phosphide. The results in the first two cases are in accordance with those obtained by Dewar. The critical constants of hydrogen phosphide are here given for the first time.—Absorption of the X-rays, by M. Abel Buguet. Methods are described by which the relation of the thickness of a substance to its opacity for the X-rays, and also its specific absorption of the latter, may be determined.—Presence of *Acari* in wines, by M. L. Mathieu. Several species of *Acari*, particularly *Glyciphagus cursor* and *Tiroglyphus farinæ*, have been observed in genuine unsweetened wines.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Valves and Valve-Gearing: C. Hurst (Griffin).—Analytic Geometry: P. A. Lambert (Macmillan). P. J. van Beneden: La Vie et L'Œuvre d'un Zoologiste: Dr. A. Kemna (Anvers, Buschmann).—A Guide to Zermatt: E. Whymper (Murray).—Durham College of Science Calendar, Session 1897-98 (Reid).

PAMPHLETS.—A Monograph on the Mechanics and Equilibrium of Kites: Prof. C. F. Marvin (Washington).—First Report upon Magnetic Work in Maryland: L. A. Bauer (Baltimore).—Report to the Local Government Board on the Preparation and Storage of Glycerinated Calf Vaccine Lymph (Eyre).

SERIALS.—English Illustrated Magazine, September (198 Strand).—Verhandlungen des Naturhistorischen Vereins, 54 Jahrg. 2 Hälfte (Bonn).—Longman's Magazine, September (Longmans).—Proceedings of the Society for Psychical Research, July (K. Paul).—Journal of the College of Science, Imperial University, Japan, Vol. x. Part 2 (Tökyö).—Quarterly Journal of the Royal Meteorological Society, July (Stanford).—Scientific Transactions of the Royal Dublin Society, Vol. vi. Series ii. ix. (Williams).—Humanitarian, September (Hutchinson).—Zeitschrift für Physikalische Chemie, xxiii. Bd. 4 Heft (Leipzig).—Chambers's Journal, September (Chambers).—Good Words, September (Isbister).—Sunday Magazine, September (Isbister).—Natural Science, September (Dent).—Century Magazine, September (Macmillan).—History of Mankind: F. Ratzel, translated, Part 20 (Macmillan).—Journal of the Royal Horticultural Society, August (Victoria Street).—Journal of the Anthropological Institute, August (K. Paul).

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THURSDAY, SEPTEMBER 9, 1897.

ABELIAN AND THETA FUNCTIONS.

Abel's Theorem and the allied Theory, including the Theory of the Theta Functions. By H. F. Baker, M.A. Pp. xx + 684. (Cambridge: at the University Press, 1897.)

CAYLEY'S often-quoted simile which compares the province of mathematics with "a tract of beautiful country seen at first in the distance, but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower," suggests a comparison of mathematical text-books with those useful works which provide information and advice for the tourist and the traveller. It may be said with truth that there is every variety, from the cheap illustrated pamphlet, designed to catch the eye of the holiday tripper in search of the picturesque, to the elaborate maps, surveys, and gazetteers which are best appreciated by the genuine explorer.

It is to the latter class that Mr. Baker's treatise belongs. It is in no sense a book for beginners; in order to appreciate it, the reader must be tolerably familiar with modern function-theory, and not wholly ignorant of the special subject of the work. Even then, he will probably find the treatise most useful as a "hand-book"; that is to say, as a methodical guide to, and commentary upon, the host of memoirs which are ultimately connected with Abel's researches on algebraic integrals. In this respect, the work is sure to be very valuable; for the author has evidently spared no pains in making himself familiar with everything of importance that has been done in this field, and in attaining, so far as possible, an impartial attitude towards the different ways in which the subject has been presented.

The title recalls the fact that not so very long ago "Abel's Theorem" was apt to be regarded by mathematical students as being something like "Taylor's Theorem" or "Ivory's Theorem": a stiff piece of isolated analysis, for which one's "coach" was expected to produce a concise and elegant proof, adapted for writing out in an examination. Even now it may be a surprise to some readers to find that a work professing to deal mainly with Abel's Theorem can extend to nearly seven hundred large and well-filled pages of print. The truth is that while Abel's Theorem is in itself a comparatively simple matter, and is perhaps best regarded as a theorem in symmetric functions, it forms a kind of centre from which several fundamental theories may be said to radiate. In order to give precision to the theorem itself, it is necessary to establish the real nature and properties of algebraic functions; Jacobi's problem of inversion, or, in other words, the introduction of Abelian functions properly so called, leads to the vast and in some ways still mysterious theory of the general theta-functions; these, in their turn, have in late years suggested an almost bewildering variety of transcendental functions; and, finally, we have the reaction of all these discoveries upon analytical geometry. It is therefore not astonishing that Mr. Baker's volume is so large; it would, in fact, have been much larger but for his studied conciseness, which, indeed, here and there, may be thought almost overdone.

In a subject like this, which, perhaps more than any other, has brought out the contrast between the intuitional and analytical schools, it is always interesting to observe an author's point of view. Mr. Baker has adopted a kind of middle course which will commend itself to those whose minds, like Cayley's, while essentially analytical, love to clothe their discoveries in the language of geometry. Thus the real start is made by assuming the existence of Riemann's fundamental integrals of the first, second, and third kind. Of course, after the work of Neumann, Schwarz, and others, there is no logical inconsistency in this; and it is convenient for purposes of exposition. But it is open to two objections: the first is, that the proof of Riemann's existence-theorems is long and difficult, when it is thorough; the second, and more essential, is that algebraic functions present themselves as special collocations of integrals, and are not considered in the first instance on their own merits; it is hard to refrain from thinking that this is, to some extent, putting the cart before the horse.

But it ought in fairness to be said, that in subsequent chapters (iii.–vii.), the analytical theory of Weierstrass, Dedekind, Kronecker, and Hensel is explained in sufficient detail to enable the reader to appreciate the other point of view; although, as a matter of fact, Weierstrass's fundamental "Lückensatz" is deduced from the existence-theorems.

Points which deserve attention in these earlier chapters are the careful explanation of "the places and infinitesimal on a Riemann surface"; the discussion of the Riemann-Roch theorem, which is unusually clear, and well illustrated by examples; and the satisfactory treatment of adjoint polynomials. As to this last point, we cannot but think that the advantage is all on the side of the analytical school. They can explain why, and in what sense, a singular point on a curve is to be reckoned as δ nodes and κ cusps in the calculation of the deficiency; can the intuitional mathematician say what δ and κ ought to be at a higher singularity of a curve described by a definite mechanical process, without finding the equation of the curve?

Chapter viii. dismisses Abel's Theorem in the course of twenty-seven pages. This brief treatment is made possible by what has gone before; still it is rather a pity that more space has not been given to an independent and purely algebraical treatment of at least the differential form of the theorem.

In chapter ix. we are introduced to the inversion problem: and here it is pleasing to find an account of Weierstrass's procedure, which is certainly the most satisfactory in giving an intelligible form to the result, although, of course, it is not a practicable method of solving the problem. For this we must have recourse to the theta-functions, and these are in fact introduced in chapter x. It is with the theta-functions and their properties that the rest of the book is principally concerned; chapters x., xi., xv.–xxi. are almost entirely devoted to them, and give, in fact, the most elaborate systematic treatment of the functions that has yet appeared

in English. The conciseness of the notation and the difficulty of the subject make these chapters very hard reading. Every one acquainted with the subject is aware that the multiple theta-functions sprang from a brilliant generalisation of Jacobi's functions $\Theta(u)$, $H(u)$, and that the *crux* of the whole matter is to establish, in a natural way, their connection with a set of algebraical functions. It is impossible to feel that this connection has been made in the really proper and natural way: the theta-functions drop out of the clouds, so to speak, and are joined up to the inversion problem in a more or less artificial and unsatisfactory manner. The most promising glimpse of a better method seems to be afforded by the "Prime Form" introduced by Schottky and Klein; and it is very satisfactory that due prominence is given to this function in chapter xiv. (on factorial functions) and elsewhere. It is very important to notice that this function admits of an independent definition, and that the three kinds of elementary Riemann functions may be directly and simply derived from it (see Arts. 233-5). Moreover there is a relation connecting any theta-function with a corresponding prime form (Arts. 237, 272-4). Thus the prime form has a strong claim to be considered fundamental; and it is not improbable that, by starting with it, the same kind of simplification may be attained as that which has been achieved in the theory of elliptic functions by the use of Weierstrass's sigma-function.

It would be unprofitable to attempt to give an abstract of the chapters on the theta-functions which Mr. Baker's book contains; enough to say that (besides the elementary properties) the relations among theta-products, the theory of transformation, and the theory of characteristics are all fully treated; account being taken not only of memoirs already classical, such as those of Rosenhain, Göpel, Hermite, and Weierstrass, but also of quite recent researches, such as those of Prym, Frobenius, Poincaré, and others. A certain amount of special attention is given to the hyper-elliptic case; this is justified by its comparative simplicity, and the large amount of literature connected with it.

Some parts of the book, especially the last two chapters (on complex multiplication of theta-functions, the theory of correspondences, and degenerate Abelian integrals), deal with problems of which the complete solution is still the object of research. This is a very welcome feature; for the unavoidable incompleteness of these parts is more than compensated by their stimulating quality. It is a pity that authors of mathematical treatises too often neglect the opportunity of carrying on a discussion to actual contact with current research, and pointing out the possible or probable direction of future development.

One characteristic of Mr. Baker's treatise seems to call for remark. On p. 93 the author says: "We desire to specify all the possibilities"; this sentence might have been adopted as a motto for the whole work. There is such a wealth of conscientious detail that we can imagine some readers failing to grasp the general argument, and becoming disheartened by the array of complicated formulæ with their plentiful adornment of suffixes. Of course, in order to treat the subject generally, a certain amount of complexity is unavoidable; there is, however, an alternative which can often be adopted, and is worth considering, namely, instead of introducing n symbols, say $x_1, x_2 \dots x_n$, to use a limited number, say $x_1\, x_2\, x_3$ or $x\, y\, z$, and to give the demonstration in such a form that its generality can be inferred. It must be admitted that this course is not always practicable; the fact is that, in order to read modern analysis with comfort, a certain facility in handling sums and products in a condensed notation is almost indispensable, and should be acquired, if possible, at an early age, as in the analogous case of definite integrals.

The book contains a considerable number of illustrative examples, many of which are worked out in detail. These cannot but be of great help to the reader, by showing how the general theory is brought to bear upon particular cases. This is especially true in the actual construction of the Riemann integrals for a given plane curve.

Printers' errors appear to be very rare; on p. 138, line 14 from the bottom, "not greater than $Q - p$" should be "not less than $Q - p$"; and in the early part of Art. 176 there are several misprints, which, however, the reader can easily correct for himself.

There can be no doubt that this work will be highly appreciated by all who make a special study of Abelian functions; and we trust that, in the approbation of the limited circle to which he appeals, Mr. Baker will find a sufficient reward for the immense amount of labour which his task must have entailed. There is still room for a strictly introductory work, bringing out the salient features of the theory, and perhaps not disdaining "heuristic" methods of investigation. In spite of its limited scope and occasional diffuseness, there is a charm about C. Neumann's book which we miss in the more analytical treatises; something of this kind in English would probably do much to draw attention to this very fascinating field of research, and induce a select few to follow up the somewhat abstruse analysis which a more detailed study of the subject involves. Some reference to the historical evolution of the theory would not be out of place; indeed, we rather regret that the plan of Mr. Baker's treatise has tended to obscure this side of the matter. Cauchy is only mentioned once, and Puiseux not at all; yet the work of these two mathematicians was fundamental, and will always form a part of any systematic discussion of function-theory.

G. B. M.

THE CULTURE OF FRUIT.

The Principles of Fruit-Growing. By L. H. Bailey. Pp. xi + 508. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

FRUIT-GROWING in this country is one of the remedies proposed to counterbalance the effects of low prices for agricultural products. But fruit-growing is an art which cannot be learned without experience. It is no easy matter for a farmer to change his habits and his practices, even if the local conditions are favourable to the production of fruit; and the orchard of the farm is very generally the most neglected part of the whole establishment. Nevertheless, it is obvious that a great extension of fruit culture has taken place during

the last few years in the vicinity of London and other large towns. At the same time, market-gardening and the growth of grapes, tomatoes and cucumbers under glass have increased enormously, and the production of flowers for market has attained proportions undreamt of by our predecessors, and unthought of even a dozen years ago. Some of those who are among the most successful of these market-growers have been farmers, but farmers possessed of a power of adapting themselves to circumstances denied to many of their fellows. It is curious also, but none the less true, that many of the most successful market-growers—men who send in grapes to Covent Garden by the ton—were not originally either gardeners or farmers. They followed some other occupation, but, deeming it advisable, they altered their plans, took to market gardening, at first on a small scale, but gradually increasing till they became the proprietors of the vast establishments which are now to be seen in every direction round London and in the vicinity of large towns. These men are very shrewd men of business, and they are specialists confining themselves strictly to the cultivation, on an enormous scale, of one or two subjects only. They are not much troubled with principles—of course we are using the word in its scientific meaning!—but they have natural intelligence enough to accumulate experience rapidly, and wit enough to make the most of its application. The private gardeners of this country grow fruit which cannot be excelled, and barely rivalled in any country on the globe; but the cost of production, though by no means lost sight of, is not of such vital moment to them as it is to the market-grower, who has to make his living out of his business.

Putting on one side these two classes of fruit-growers, the market specialists and the gentlemen's gardeners, who both grow fruit well, there remains another class, the largest in numbers, the most widely scattered, and, we fear we must add, the most deficient, alike in principles and in practice. They are neglectful of the one, and unable to appreciate the value of the other. Yet this is the class that is suffering the most severely from agricultural depression, and the one for whose benefit fruit culture is prescribed. It is, however, pretty clear that little advance can be expected in the case of the present generation; it is to the younger generation now coming on that we must look for the results of technical education and technical training that are now more or less available. To these the work before us will be full of suggestions.

Over a large area of the United States fruit culture is carried on to an extent that is hardly realisable here, and it is "much more of a business" than it is with us. The author gives advice as to the locality and climatal conditions under which success may be confidently hoped for, deals with the methods of tillage, cultivation and manuring, and enumerates the most suitable varieties for particular purposes. The best modes of picking, grading, packing and sending to market are discussed. On the whole we find more of the practice than of the principles in this book; but it is so full of information and so replete with suggestion that we shall not cavil at its title, but recommend it to thoughtful cultivators who will be able to adapt it to their own uses —a process rendered easier by the table of contents and index with which the volume is provided.

OUR BOOK SHELF.

Masonry Dams from Inception to Completion, including numerous Formulæ, form of Specification and Tender, Pocket Diagram of Forces, &c. By C. F. Courtney, M.Inst.C.E. Pp. 103 + 33. Appendix. (London: Crosby Lockwood and Son, 1897.)

This book purports to be written for civil and mining engineers, but it is difficult to understand what purpose it is intended to serve. The author very correctly states in his preface that it is not an exhaustive treatise. The book is not sufficiently elementary for students, and contains practically nothing that a waterworks engineer of any experience would not be acquainted with. As regards its use by mining engineers, there is no special reference to the use of masonry dams for mining purposes, or examples given where masonry dams have been used for this purpose.

A scientific treatise may be valuable as a record of the views and experience of an author who has himself been largely concerned in designing and carrying out works of the nature dealt with. This book cannot come under this head, as from the description given on the title-page, it appears that until recently the author had only filled the office of assistant engineer to an Engineering Company and in the City Surveyor's office, Manchester. A treatise may also be of service where the author, having a practical knowledge of the subject with which he deals, collects together and puts into readable form theories, facts and descriptions of works scattered about in scientific proceedings and in the engineering journals. Such a work on the subject here dealt with would be of value, as giving examples of masonry dams which have been constructed in this and other countries, with illustrations of the sections and profiles adopted, and an account of the materials used in the construction. Such information is, however, conspicuous by its absence in the present volume, the only examples given being those of the Quaker Bridge and the Bouzey dams. Even the Vyrnwy dam for the Liverpool water supply, which during its construction excited a very large amount of attention and controversy, is only incidentally referred to.

The chapters on construction and calculations of stability contain some useful information, but nothing that is original or that has not been already as well told in books already in existence, and there are misprints in some of the figures which might prove very misleading if made use of.

It is at present the practice for those engaged in questions of water supply to use as units of measurement acres and square miles as areas, inches for rainfall, and gallons or cubic feet for quantities. The author, however, makes a free use of the metric system, and give a formula for what he terms "simplification of calculation," the units of which are expressed in centimetres and square and cubic metres. In other parts of the book the measurements and quantities are sometimes given in metric, and in other parts in English measures, and in one place the result of kilogrammes per cubic metre is given in pounds per cubic foot.

Biblioteca di Scienze Moderne, No. 1. *Africa: Antropologia della Stirpe Camitica.* By Giuseppe Sergi. Pp. 426. (Turin: Bocca, 1897.)

Prof. Sergi is an anthropologist whose views differ widely from those of other writers on the science, who, he complains, have down to the present left the subject in a state of chaos. In the present work he seeks to apply an improved method to the study of a particular section of mankind, viz. the Hamites of Africa. In subdividing the human race, Prof. Sergi depends on purely physical characters, discarding linguistic facts as untrustworthy as indications of affinity. He draws a broad distinction between what he terms the internal and external physical

characters, the former relating to the bony skeleton—particularly the skull—while the latter include such secondary characters as the colour of the skin, form of the hair, &c. He holds that the former are persistent, and that even in the case of a mixture of races they are not modified, but rather that the type of one or other of the parent stocks is maintained. The external characters are subject to modification from the influence of environment and other causes, so that the only trustworthy criterion of race is supplied by the internal.

Having in the body of the work examined in detail the various groups of Hamites in Africa, the author discusses in the final chapter the position occupied by them in the scheme of classification. Their internal characters show, he holds, a decided unity of type, which corresponds also with that found among the peoples of South Europe, already studied by him in a previous work. He therefore places the African Hamites with the South Europeans (and possibly the Semites) in one group, which he considers entitled to rank as a *species*, the word being understood in the sense of an animal group with fundamental characters not common to other groups. To it he applies the term "Eurafrican," but in a different sense to that in which it is employed by Brinton, Flower and Keane. Prof. Sergi's whole system thus rests on the supposed permanence of one set of characters, which is unlikely to be accepted as proved without further evidence, but the book is suggestive and valuable for the mass of facts which it brings together. It is abundantly illustrated with portraits of the different Hamitic types.

The A.B.C. of the X-Rays. By William H. Meadowcroft. Pp. 189. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd.)

"THE main object of this book," says the author, "is to present to the reader a practical explanation of apparatus and methods employed in producing and utilising the X-rays." To introduce the subject, there is a chapter in which various properties of light and electricity are described for the benefit of the general reader, to whom lenses and photography and the electric current are mysterious things. Following this is a brief mention of the apparatus used for exciting vacuum tubes, and then come chapters on induction, induction coils, contact breakers and condensers, and high frequency apparatus. There is a chapter on influence machines, and in it we have the usual descriptions of positive and negative electricity, with diagrams of their distribution upon an electrophorus in various stages; the attractions and repulsions of positive and negative are also traced in detail in the account of the Holtz machine. Eventually (Chapter ix.) we arrive at "The Crookes' tube," and are informed how Prof. Elihu Thomson, "as early as January 1896," found after an "exhaustive series of experiments," that the form of tube known as the focus tube was the best for Röntgen ray work. We also learn that Mr. Shallenberger and Mr. Scribner used this standard form of tube early in 1896, but nothing is said of the prior use of the focus tube by Mr. Herbert Jackson in this country. Mr. Edison is given "the credit of making the practical device known as the Fluoroscope," to the description of which a chapter is devoted. Probably Mr. Edison would not himself claim much credit for the very obvious extension of Prof. Röntgen's original observations involved in the construction of the fluoroscope. Moreover, the instrument is practically the same as the cryptoscope described by Prof. Salvioni at the beginning of February 1896.

The remaining short chapters of the book deal with the sources of excitation of vacuum tubes, manipulation of apparatus, practical suggestions, and photographic plates and developers.

Though published in London, the book is evidently an American production.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Corona Spectrum.

IN your article on the approaching solar eclipse (page 393, paragraph 2), reference is made to the apparent absence of the corona line, 1474 K, from the chromosphere and prominences. I would like to point out that occasionally this line is clearly seen reversed in metallic prominences; and that the form of the prominence, generally a very small one, can be made out with the widened slit as in the other chromosphere lines. Such an instance is recorded by Fenyi, who has published a drawing of the prominence as seen in the lines 6677, C, and 1474 K; the height as measured in the last-named line being 33" ("Astronomy and Astro-physics," xi. 432, 1892).

Prominences of 1474 light very rarely reach this altitude above the limb, but the writer has several times noted small metallic prominences reversing the corona line; and during 1895 (a year of great relative frequency) the line was recorded "bright" in the chromosphere twelve times in 134 days of observation; always in the spot latitudes, and at the very base of the chromosphere, never in the coronal region above. Although not therefore truly coronal in this sense, these reversals may possibly have formed the bases of the bright coronal streamers which emanate from the spot zones during a maximum spot period.

With regard to the H and K radiations, the evidence now seems conclusive that these lines were not present in the corona of 1893, and it may be assumed that the lines photographed by Deslandres during this eclipse, with slit spectroscopes, were due to atmospheric diffusion of the brilliant chromosphere radiations, as suggested by the writer at the time the results were published (NATURE, xlviii. 268, 1893). The relative displacements measured by Deslandres on opposite sides of the solar equator would seem, therefore, merely to prove a rotation of the *chromosphere*, not of the corona. J. EVERSHED.

August 29.

The late Earthquake in India.

THE following extract from a letter just received from my son, who is at present in Assam, investigating the effects of the recent earthquake, may be of interest. In communicating it to NATURE, he wishes it to be understood that his remarks on the cause of the event are but tentative and subject to revision on further information which is being collected by his colleagues on the Survey. J. D. LA TOUCHE.

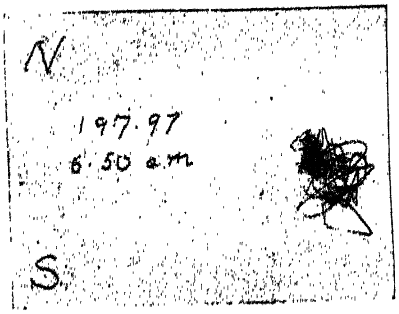
Stokesay, Craven Arms, August 18.

"*Shillong, July* 23.

"You will, no doubt, have been greatly interested in hearing of this earthquake, though from the accounts that have been telegraphed home you will not have got much information about it. All this talk of railways disappearing, and whole villages being swallowed up, is very far beyond the facts; though, indeed, things are bad enough. The whole of the damage was done by the first great shock, which lasted in these parts about two minutes. After that there were a number of other shocks, estimated at between 300 and 400, in the first twenty-four hours, but none of them nearly so violent as the first. The ground certainly was fissured in many places, and a large quantity of sand and mud was thrown out; but this is a secondary effect of the earthquake, and happens only in loose soil or in the alluvium of the valleys. Such fissures occur near river-banks and such-like places, and are due to the forward movement of the soil where no mass exists in front of the wave to carry on its motion, somewhat analogous to the forward movement of waves of water when they reach the shore. The fissures are quite superficial, and the sand and water is merely jerked out of them, of course during the actual progress of the shock only. The statement that sand and mud are constantly spurted out, is quite misleading. These fissures were studied by Dr. Oldham in the Cachar earthquake of 1869, when he found out the cause of them. The loss of life has been very small: only one child at Dhubri and a few at Goalpara, where one of these fissures opened under one side of the bazaar, and filled the street and houses with sand. The river there only rose eight feet, and did not reach the bazaar itself. A

small portion of the crops has been destroyed by sand and mud, but nothing like the amount that was supposed at first. Here every house and structure that was built of stone was simply shaken to pieces; but the buildings were never intended to stand earthquakes, and when one sees the kind of structures they are, great shapeless lumps of stone laid in very inferior mortar, one is not surprised that they all came down, though it is doubtful whether the best of masonry would have stood the shock. In the cemetery huge slabs of granite or marble have been jerked several inches out of their places. It has been most interesting work investigating the results of the shock. I have not yet heard what opinion my colleagues, who have gone out in various directions to make observations, have formed about the cause of the shocks; but my own opinion is that they are due to movement along a line of fault running along the southern side of the Khasia and Garo Hills, from near Cachar on the east to and beyond the Bramahputra. If you look at the map of Assam you will see that the southern boundary of these hills is a very straight line. The rocks are bent down suddenly along this line in a uniclinal curve, and to the south of it the plains of Sylhet and Lower Bengal are certainly a region of subsidence. If I should prove to be right, it will be a most interesting case of earth-movement on a large scale. I believe also that the 'Barisal guns,' which have been a puzzle for so many years, are connected with the same movement, and are caused by slight slips, not sufficient to cause actual shocks of earthquake. The sounds one hears here, sometimes accompanied or followed by a shock, but sometimes also without any shock, are exceedingly like the 'guns.'

"At the beginning of the week I put up here a roughly constructed seismograph for observing the shocks, which still continue, though they are gradually getting less violent and less frequent than at first. The instrument is in principle, I believe, due to Prof. Ewing, of Tokio, and gives a trace of the horizontal movement of a point on the surface of the earth on a piece of smoked glass. From this it is easy to take prints on a piece of sensitised paper, and I send you some of the results [one of the prints is here reproduced] I have already obtained. The trace is magnified 6·7 times by the instrument, so that one can form an idea from it of how exceedingly minute the actual movement of the surface is, and yet the two taken in the morning of the 19th were fairly severe shocks. The first, at 1.39 a.m., was a very sudden bump, and was soon over; but the other, at 6.50 a.m., lasted some fifteen to twenty seconds. This instrument cost altogether about 6*d.* to put up; I am making another rather more carefully, which will be looked after by the Public Works Engineer here when I leave.



"The house I used to live in is perfectly flat on the ground. It is wonderful that so few people were killed; but the first shock came at a time of day when most people were out of doors, and only two Europeans were killed and about ten natives, who were all in the Government Press building, the only house of more than one story in the place. If it had happened at night, or at the same time next day, when many of the people would have been at church, there would have been great loss of life. I am going on from here to Cherrapungi, where the damage has been very great, chiefly caused by landslips, and then back to Calcutta through Sylhet."

The Centipede-Whale.

I AM very much desirous of being informed by you, or some of your readers, what animal is meant by "Scolopendra Cetacea," which, according to Johnston, has only been described by Ælian: "Scolopendrae vim et naturam, . . . quoddam etiam maximame cêtos marinum eam esse audivi, quam de mari tempestatibus in litus expulsam nemo foret tam audax, quin aspicere horreret. Ii verò qui res maritimas percallent, eas inquiunt toto capite spectari eminentes è mari: et narium pilos magna excelsitate apparere, et ejus caudam similiter atque locustae latam perspici: reliquum etiam corpus aliquando in superficie aequoris spectari, idque conferri posse cum triremi instae magnitudinis, atque permultis pedibus utrinque ordine sitis, tanquam ex scalmis appensis, natare. Addunt harum rerum periti ac fide digni, ipsos etiam fluctus ea natante leviter subsonare." ("De Natura Animalium," lib. xiii. cap. 23.) In Gesner's "Historia Animalium," lib. iv., Francfort, 1604, p. 838, a figure is given of this animal said to have been seen in India.

That the Japanese of old had some notion of such an animal is well shown in Kaibara's "Yamato Honzô" (1708, tom. xiii. f. 41, b.), where it is said: "The *Mukade-Kujira* [= Centipede-Whale] is as large as a whale, and has five fins on the back and a two-cleft tail. Its legs number twelve, six being on each side; its flesh is coloured red and very venomous, man being killed when he eats it."

Here I may add that Olaus Magnus's "Cetus Barbatus," which is assimilated with the "Scolopendra Cetacea" in the book of Gesner (*ut supr.*, and figured on p. 207), appears to be but an exaggerated portrait of some huge Cephalopod; and also that I was lately told by Captain Miura, of the *Fuji*, of his having experienced a serious illness in consequence of eating flesh of a gigantic cuttlefish in the Pacific Ocean.

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, W., August 30.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

VI.

IN the third article under the above heading, when referring to the suggested programme for the observations of the next eclipse, I stated briefly the divergent views held with regard to the true *locus* of origin of the absorption which produces the Fraunhofer lines. It is, I think, worth while to return to this subject in order that the results obtained from the double series of photographs obtained during the eclipse of 1893 may be indicated. I pointed out that in the photographs in question the radiation spectrum was most distinctly *not* identical with the Fraunhofer spectrum; the most important point being that some of the strongest bright lines do not appear among the dark ones in the solar spectrum, while some of the strongest dark lines are not seen bright in the spectrum of the stratum of vapours in immediate contact with the photosphere. The region covered by the diagram, given in my paper in the *Phil. Trans.*, lies between wave-lengths 4100 and 4300, but similar results follow when other regions are included in the inquiry.

These positive conclusions are not weakened by the consideration that the resolving power of the prismatic cameras employed in 1893 is not sufficiently great to show all the lines of the Fraunhofer spectrum, which is used as a term of comparison; in fact, working under exactly the same conditions as during the eclipse, the instrument employed in Africa only shows 104 lines in the spectra of stars resembling the sun, in the region *h* to H, in place of 940 given in Rowland's tables of lines in the solar spectrum. We, therefore, get a better term of comparison if we employ the spectrum of some star such as Arcturus, which closely resembles the sun. Such a comparison is shown in Fig. 24; out of 104 lines which the instrument is capable of depicting in the region *h* to H, only 40 are shown in the spectrum of the base of the sun's atmosphere. This comparison amply confirms the conclusion that the lines reversed at the beginning or end of totality, though fairly numerous, do not correspond in intensity, though some of them correspond in position with the dark lines of the solar spectrum, and consequently that the so-called "reversing layer" close to the photosphere is incompetent to produce, by its absorption, the Fraunhofer lines. Further, as previously pointed out, while the chromosphere fails to show most of the lines

[1] Continued from p. 395.

which are present in the Fraunhofer spectrum, it shows many bright lines which are not represented among the dark ones. This again indicates that the chromosphere is not the origin of the Fraunhofer spectrum

It is all the more important to call attention to the advantage we now possess in being able to directly compare photographs of the chromosphere obtained during eclipses with others of the spectra of stars resembling the sun, since, as I have already stated, if all goes well next year, double the dispersion utilised in 1893 will be employed. This is certain not only to enable us to obtain more accurate wave-lengths, but the number of Arcturus- and chromospheric-lines *obtained by the same instrument* will be very greatly increased.

In the meantime we must take the above as one of the most positive results secured in the eclipse of 1893.

The Spectra of Prominences at Different Heights.

There is another matter of almost equal importance in which the increased dispersion designed to be employed in 1898 will in all probability prove of the utmost value. I refer to the differences in the spectra as we work outwards from the photosphere.

The questions touching the spectra of prominences at different heights, which the prismatic camera enables us to study with minuteness, must really lead in time to a much better knowledge of the loci of absorption in the solar atmosphere. If we consider a prominence on that part of the sun's limb where the second contact takes place, the first photograph taken during totality will show the spectrum of the whole prominence, and succeeding photographs will give the spectrum of the same prominence with the lower parts gradually cut off by the moon's edge. In the case of a prominence at the opposite limb, similar sections will be represented in successive photographs, and the last photograph taken during totality will show the spectrum of the greatest part of the prominence.

Some of the 1893 prominences (Nos 3 and 19) have been investigated in this way, and particulars of their spectra at various heights recorded. The height above the photosphere, reckoned in seconds of arc and in miles, at which each spectrum is given, has been calculated. The relative intensities of the lines at different heights have been tabulated. In this way it has been found that some of the lines remain of the same relative intensity throughout all parts of the same prominence; others again dim rapidly in passing towards the upper parts, while some, but not so many, brighten.

The prominences are also seen to behave differently in respect to some of the lines; thus the line at λ 3856·5 disappears before a height of 2000 miles is reached in prominence No. 3, but remains visible at a height of over 4000 miles in prominence No. 19. Lines also occur in one prominence which do not appear in the other, *e.g.* λ 4313·2. Other differences are also revealed, but it may be remarked that too much stress should not be laid on the presence or absence of the very faintest lines in some of the photographs, as variations may be partially attributed to differences in the quality of the photographs, and also to the time of exposure and degree of development.

The changes in the spectrum of a prominence in passing from the top towards the base are illustrated in Fig. 25. Spectra *a*, *b*, and *c* represent the spectrum of Pro-

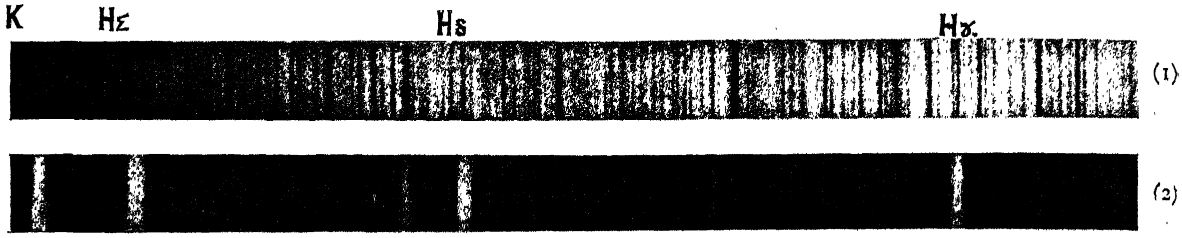


FIG. 24.—The spectrum of Arcturus (1) compared with that of the base of the chromosphere photographed during the eclipse of 1893 (2).

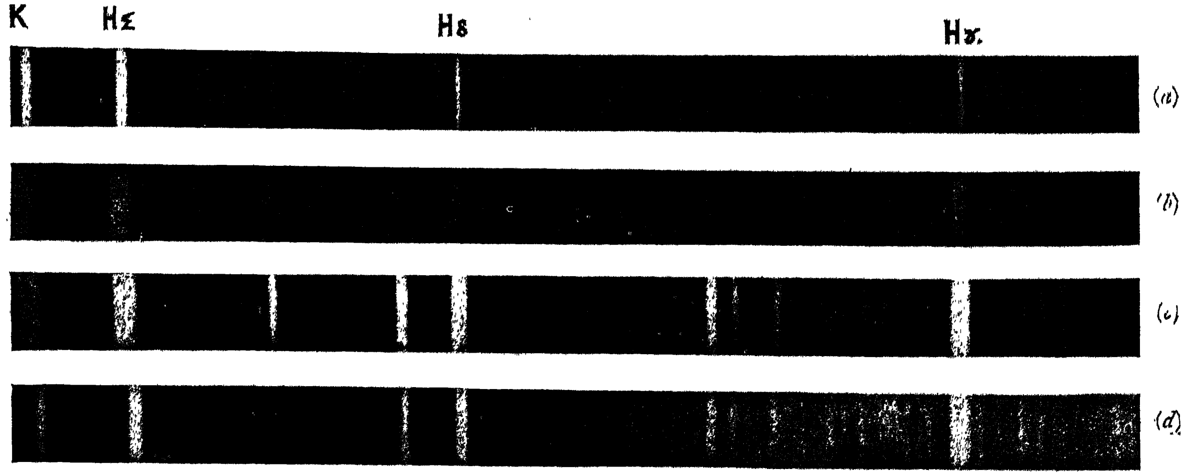


FIG. 25.—The spectra, *a*, *b*, *c*, of Prominence No. 3, photographed during the eclipse of 1893, compared with the spectrum of the base of chromosphere (*d*).
(*a*) 22″–26″ above photosphere.
(*b*) 7″–9″ ,, ,,
(*c*) 3″–4″ ,, ,,

minence No. 3 as it appears in the African Photographs Nos. 11, 9, and 7 respectively, the first giving the spectrum of the upper part only, while the last shows the spectrum nearer the base. Accepting the time of commencement of totality in Africa as 2h. 23m. 48s. by the deck watch, it has been calculated that Spectrum 1 represents a part of the prominence 22″–26″ (9950 to 11,600 miles) above the photosphere; Spectrum 2, 6″·7–8″·5 (3000 to 3800 miles); and Spectrum 3, 3″·7 (1660 miles) above the photosphere. Strip *d* is the spectrum of the base of the chromosphere as represented by the cusp in the African Photograph No. 22.

These enlarged spectra have been obtained by covering copies of the original negatives with tinfoil, leaving only narrow strips showing the prominence spectra, and giving them the necessary width by moving the photograph in a direction at right angles to the length of the spectrum.[1]

The want of exact coincidence of lines common to different horizons in the copies of the photographs which I have given is due to the difficulty of obtaining enlargements on exactly the same scale. The difference in thickness of the same line in different photographs of a prominence is due to the varying widths of the corresponding images of the prominence formed by the prismatic camera at different stages of the eclipse.

In order that the changes of intensity of the various lines may be separated from the effects due to varying exposures, the individual observations are arranged in groups according to the time of exposure of the photographs.

In contrasting the spectrum of the prominences with the spectrum of the cusp, it should be borne in mind that the cusp in the African photograph specially examined (No. 22), does not represent the base of the chromosphere immediately beneath either of the metallic prominences. Still the cusp was not far from a prominence (No. 19), and it is fair to consider the base of the chromosphere homogeneous. If so, the prominences cannot be fed from the base of the chromosphere, since they contain different vapours.

The Spectrum of the Chromosphere at Different Heights.

But we are not limited in these investigations to the study of the prominences; we can obtain similar information from the chromosphere itself.

The spectrum of the chromosphere itself at different heights can also be partially investigated in the eclipse photographs. A considerable arc of chromosphere was photographed in one of the African negatives (No. 21). The photograph was taken about ten seconds before the end of totality, so that the lower reaches of the solar atmosphere within 1660 miles of the photosphere were hidden. The bright arcs accordingly represent the spectrum of the chromosphere above that height. None of the photographs give us any information as to the spectrum lower down until we come to the part very near to the base which is shown at the cusp in another photograph (22). Most of the lines become relatively brighter as the base of the chromosphere is approached, but some become dimmer.

The Evidence as to the Existence of Layers in the 1893 Photographs.

The most direct evidence which the eclipse photographs give as to the separation of the solar atmospheric vapours into layers is that afforded by the increased relative brightness of some of the lines in passing to higher levels.

We have seen that a careful and impartial tabulation of intensities has shown that both in the prominences and in the chromosphere some vapours do seem to be brighter as they increase their distance from the photosphere.

[1] *Phil Trans.*, 1893, vol. clxxxiv. A. p. 684.

As we have to deal with the projection of a sphere and not with a section of the sun's atmosphere, the spectrum arcs would brighten in passing outwards from the photosphere in consequence of the increased thickness of vapour presented to us, even if the radiation per unit volume remained constant. The spectroscopic differences studied and carefully recorded show, however, numerous inversions even in the behaviour of the same line in different prominences, so that the increased brightness observed cannot always be due to this cause alone.

Some of the lines are brightest at the base of the chromosphere, while others are brighter at greater elevations. As already explained, some of the lines which are brightest above the photosphere are probably produced by vapours existing in layers concentric with, but above and detached from the photosphere. Those lines which become dimmer in passing outwards must owe their origin to vapours resting on the photosphere.

It will be obvious to everybody that the more the idea of the absorption which gives rise to the Fraunhofer lines taking place in one thin layer is disproved, the more certain it must be that it represents the integrated effect of several layers. Hence this special examination of the 1893 photographs, to which I am now directing attention, to see if there are any indications as to the localisation of the absorbing vapours which are not represented in the base of the chromosphere.

It will be noted that the evidence is distinctly in favour of such localisation *above* the chromosphere.

But the matter is so important that it must not be allowed to rest here, while photographs with higher dispersion are possible. Hence, then, the 1898 results must be carefully studied from this point of view.

The Chemical Constitution of the Sun's Atmosphere.

The results obtained with regard to the chemistry of the sun will, of course, depend upon the results of the accurate measurement of the arcs, both long and short, obtained in the prismatic cameras; and of the lines—true images of the slit—in slit spectroscopes; these measurements have for their object the determination of the wave-lengths of the radiations, so that they can be compared with the wave-lengths of terrestrial substances observed in the laboratory.

The dispersion employed in 1893 was only moderate as compared with that now used in laboratory work, though it was far greater than any employed in eclipse observations before. The doubled dispersion proposed for 1898 will necessitate additional precaution against error, and in return it may land us in new discoveries. To show that this remark is justified, I will first refer to the method employed in the determination of wave-lengths in the case of the photographs of the 1893 and 1896 eclipses.

The wave-lengths are expressed on Rowland's scale. In the region less refrangible than K, they have been determined from the African photographs, by comparison with the spectrum of Arcturus and other stars photographed with the same instrument, the wave-lengths of the lines in which were determined by reference to Rowland's photographic map. The spectrum of Arcturus is almost identical with that of the sun, so that the comparison lines were sufficiently numerous for the purpose. Stars like Bellatrix were employed as an additional check in the case of bright lines not coincident with prominent Fraunhofer lines.

Micrometric measurements of the lines were also made and reduced to wave-lengths in the usual way, by means of a curve; these furnished a check on the general accuracy. In the case of the Brazilian negatives wave-lengths were determined by means of micrometric measures and a curve, and checked by direct comparisons with a solar spectrum, photographed with the same spectroscope while it was temporarily provided with a slit and

collimator. For the reduction of the ultra-violet, in both series of photographs the wave-lengths of the hydrogen lines have been assumed as far as $H\phi$ from those given by Hale,[1] with the exception of H_v, which falls sufficiently near the calculated wave-length to be accepted as a hydrogen line.

With these as datum lines, wave-length curves were constructed, and the wave-lengths of the other lines found by interpolation.

The wave-lengths of the radiations more refrangible than $H\zeta$ were determined from extrapolation curves, so that the degree of accuracy is necessarily less than in the case of the remaining lines.

The scale of intensities adopted is such that 10 represents the brightest lines and 1 the faintest. This facilitates comparisons with Young's well-known list of chromospheric lines, in which 100 represents the maximum frequency and brightness. The intensities have been estimated by taking the strongest line in each negative as 10, irrespective of length of exposure.

This much being premised, let us next consider the thing that is actually measured. If we study the actual photographs, or such reproductions as have been given in Figs. 17 and 18, it will be clear in a moment that the arcs are of different widths because some of the vapours and gases extend further above the photosphere, and therefore above the dark moon which covers it during an eclipse, than others. Obviously, then, we must not take the *centre of the arc*. It is also obvious that we must not take that edge further from the dark moon. If we did either of these things, the positions of the lines thus recorded would depend not only on the wave-length of the radiations of the vapours and gases which produced them, but also upon the thickness of the vapours.

If, however, we take the edge of the arc at the moon's edge, in every case we shall have a series of numbers involving wave-length only, *except under two conditions*, and this is a very important exception.

The first condition which may vitiate the determination of wave-length in this way is that some of the vapours or gases producing certain lines may be in movement sufficiently rapid along the line of sight to change the wave-lengths of the lines according to a well-known law. Suppose, for instance, we have a stream of iron vapour moving at the rate of fifty miles a second towards the eye through a mass of hydrogen at rest; the lines of the iron spectrum will be shifted towards the violet part of the spectrum, while those of hydrogen will be in their normal position. The higher the dispersion employed, the more carefully must such matters as this be studied. This cause, in fact, will in the case of very violent motion change even the forms of the prominences.

The forms of monochromatic images of the prominences being produced in part by the movement in the line of sight of the vapours which give rise to them, regions in which the vapours are approaching the earth will be displaced to the more refrangible side of their true positions with respect to the sun's limb, and in the case of receding vapours there would be displacements towards the less refrangible end. Such distortions can be determined, if they exist, by comparing the monochromatic images with those photographed at the same time with the coronagraph. For this purpose, in dealing with the eclipse of 1893 a photograph of the eclipsed sun was enlarged to exactly the same size as the K ring shown in Fig. 9, and the comparison could be made very exactly by fitting a negative of one to a positive of the other. No differences of form, however, could be detected, so that the velocities in the line of sight must have been comparatively small. Movements across the line of sight will not affect the forms of the monochromatic images of the prominences.

[1] "Astronomy and Astrophysics," 1892, pp. 50, 602, 618.

This is a true physical origin of the change of wave-length which may be detected in eclipse photographs; but there is a second, as I have hinted. This, although only an apparent change, has to be reckoned with, since, on the one hand, it may be very misleading, while, on the other, if properly dealt with, it may furnish us with new knowledge.

I have already pointed out that in the determination of the wave-length of the arcs in the prismatic camera photographs the edge of the line nearest to the dark moon must be measured, rather than the other edge or the middle of the arc. But this assumes that all the arcs really rest on the dark moon. *It is possible, however, that some of them do not extend down to it—that they represent real upper layers*, and in this case the wave-length obtained by a reference to the dark moon will not be the true one, and, by some means or another, it will have to be corrected. This, though a difficult problem, does not seem an impossible one.

Eclipse Work in relation to the Dissociation Hypothesis.

In the course of the spectroscopic solar investigations which have been going on since 1868, I have pointed out over and over again that the phenomena observed could be more easily explained on the hypothesis that the chemical elements with which we are familiar here were broken up by the great heat of the sun into simpler forms, than in the ordinary one that the "elements" as we deal with them in laboratories are incapable of simplification, that is that they are indestructible.

The recent work on the enhanced lines of several of the metallic elements, really enables us to predict what we shall obtain in the Indian eclipse if the dissociation hypothesis be true.

With regard especially to the bearing of the 1893 work on this view, I may state that it is entirely in its favour. The preliminary discussion of individual substances has further abundantly shown that although some of the lines belonging to any particular metal may appear as dark lines in the solar spectrum on account of absorption by the chromosphere, other lines of the same substance are only represented among the dark lines because of absorption taking place elsewhere. This again is an indication of the stratification of the sun's absorbing atmosphere, which, if it exists, must furnish a very strong argument in favour of the dissociation of metallic vapours at solar temperatures. In fact, the eclipse phenomena have been found to be as bizarre, in relation to the non-dissociation hypothesis, as those which I have already discussed in relation to observations of sun-spots, chromosphere, and prominences, made on the uneclipsed sun.

The long-continued Italian observations of the quiet solar atmosphere and the Kensington observations of sun-spots have already been especially mentioned. Not only is there no correspondence in intensity, but the variation in the sun-spot spectrum from maximum to minimum is enormous, while the Fraunhofer lines remain constant.

The view I expressed in 1879,[1] and to which I adhere, is therefore strengthened by the eclipse work. I then wrote: "The discrepancy which I pointed out, six years ago, between the solar and terrestrial spectra of calcium is not an exceptional, but truly a typical, case. Variations of the same kind stare us in the face when the minute anatomy of the spectrum of almost every one of the so-called elements is studied. If, therefore, the arguments for the existence of our terrestrial elements in extra-terrestrial bodies, including the sun, is to depend upon the perfect matching of the wave-lengths and intensities of the metallic and Fraunhofer lines, then we are driven to the conclusion that the elements with which we are acquainted here do not exist in the sun."

[1] *Roy. Soc. Proc.*, 1879, vol. xxviii. p. 13.

Conclusion.

In the course of this series of articles, I have referred to the many points on which light was thrown by the observations made in 1893.

It is quite obvious that the aim of those who observe in India next year with the view of advancing the more important problems of physics and chemistry presented to us by the eclipsed sun, should work along the new lines with a view of testing the soundness of the conclusions so far arrived at, and of obtaining new knowledge. I cannot, I think, more fitly close this article than by giving a very brief summary of the conclusions arrived at in the observations of 1893, so that my readers can gather the drift of much of the work that will be undertaken in 1898.

(1) With the prismatic camera photographs may be obtained with short exposures, so that the phenomena can be recorded at short intervals during the eclipse.

(2) The most intense images of the prominences are produced by the H and K radiations of calcium. Those depicted by the rays of hydrogen and helium are less intense and do not reach to so great a height.

(3) The forms of the prominences photographed in monochromatic light (H and K) during the eclipse of 1893, do not differ sensibly from those photographed at the same time with the coronagraph.

(4) The undoubted spectrum of the corona, in 1893, consisted of seven rings besides that due to 1474 K.

The evidence that these belong to the corona is absolutely conclusive. It is probable that they are only represented by feeble lines in the Fraunhofer spectrum, if present at all.

(5) All the coronal rings recorded were most intense in the brightest coronal regions near the sun's equator as depicted by the coronagraph.

(6) The strongest coronal line, 1474 K, is not represented in the spectrum of the chromosphere and prominences, while H and K do not appear in the spectrum of the corona, although they are the most intense radiations in the prominences.

(7) A comparison of the results with those obtained in previous eclipses confirms the idea that 1474 K is brighter at the maximum than at the minimum sun-spot period.

(8) Hydrogen rings were not photographed in the coronal spectrum of 1893.

(9) D_3 was absent from the coronal spectrum of 1893, and reasons are given which suggest that its recorded appearance in 1882 was simply a photographic effect due to the unequal sensitiveness of the isochromatic plate employed.

(10) There is distinct evidence of periodic changes of the continuous spectrum of the corona.

(11) Many lines hitherto unrecorded in the chromosphere and prominences were photographed by the prismatic cameras.

(12) The preliminary investigation of the chemical origins of the chromosphere and prominence lines enables us to state generally that the chief lines are due to calcium, hydrogen, helium, strontium, iron, magnesium, manganese, barium, chromium, and aluminium. None of the lines appears to be due to nickel, cobalt, cadmium, tin, zinc, silicon, or carbon.

(13) The spectra of the chromosphere and prominences become more complex as the photosphere is approached.

(14) In passing from the chromosphere to the prominences some lines become relatively brighter, but others dimmer. The same lines sometimes behave differently in this respect in different prominences.

(15) The prominences must be fed from the outer parts of the solar atmosphere, since their spectra show lines which are absent from the spectrum of the chromosphere.

(16) The absence of the Fraunhofer lines from the integrated spectra of the solar surroundings and uneclipsed photosphere shortly after totality need not necessarily imply the existence of a reversing layer.

(17) The spectrum of the base of the sun's atmosphere, as recorded by the prismatic camera, contains only a small number of lines as compared with the Fraunhofer spectrum. Some of the strongest bright lines in the spectrum of the chromosphere are not represented by dark lines in the Fraunhofer spectrum, and some of the most intense Fraunhofer lines were not seen bright in the spectrum of the chromosphere. The so-called "reversing layer" is, therefore, incompetent to produce the Fraunhofer spectrum by its absorption.

(18) Some of the Fraunhofer lines are produced by absorption taking place in the chromosphere, while others are produced by absorption at higher levels.

(19) The eclipse work strengthens the view that chemical substances are dissociated at solar temperatures.

NORMAN LOCKYER.

VICTOR MEYER.

VICTOR MEYER was born on September 8, 1848, and died on August 8, 1897. He studied chemistry at Heidelberg, under Bunsen, and at Berlin, under Baeyer. His first official appointment was at Stuttgart, whence he was called, in 1872, to the chair of Chemistry at the Zürich Polytechnic. In 1885 he went to Göttingen, and in 1889, on the retirement of Bunsen, he was appointed Professor of Chemistry at Heidelberg. The later years of his life were clouded by ill-health. His almost abnormal mental activity allowed him no rest, and he suffered greatly from insomnia. To the effects of this malady on a highly sensitive nervous organisation must be ascribed his tragic death in the midst of a career which, brilliant though it was, gave promise of still greater things in the future.

As an investigator Victor Meyer undoubtedly stands in the very front rank. In these days of specialisation it is given to but few men to possess a complete mastery over more than one department of a science. Meyer was equally at home when dealing with the problems of physical chemistry and when working out the chemistry of a group of organic compounds.

His first important investigation was that on the nitro-paraffins. In 1872 he discovered nitro-ethane, and, following this up with characteristic energy, had soon studied several of its homologues, as well as secondary and tertiary nitro-paraffins. By the action of nitrous acid on these substances he obtained nitrolic acids and pseudo-nitrols, and, by his study of these substances, cleared up the constitution of iso-nitroso and nitroso compounds. In 1882 he made the important discovery that iso-nitroso compounds are formed by the action of hydroxylamine on aldehydes and ketones. The generality of this reaction has been of considerable importance in the determination of the constitution of organic compounds, affording a sure indication of the presence of a carbonyl group.

Meyer's discovery of the oximes may be regarded as the foundation of our knowledge of the stereochemistry of nitrogen, for in 1888, working with his pupil Auwers, he showed that the two isomeric benzil dioximes then known were structurally identical. It is of interest that the molecular weights of these bodies were shown to be identical by means of the, then little known, cryoscopic method. To the further development of the stereochemistry of nitrogen, Meyer and his pupils contributed not a little.

The discovery of thiophene in 1882 by Victor Meyer was the result of a lecture experiment which failed. Benzene prepared from benzoic acid was shaken with strong sulphuric acid and isatin, and failed to give the

usual blue colouration. Further investigation revealed the fact that the blue colouration is due to an impurity in ordinary coal-tar benzene, viz. thiophene. The discovery of this remarkable substance was of great importance, giving a deeper insight into the nature of aromatic substances. Six years after the discovery of thiophene, he was able to publish a monograph "Die Thiophengruppe," containing a masterly account of thiophene and its derivatives, practically the whole of the work having been carried out in his own laboratory.

Another extremely interesting group of compounds, our knowledge of which is due to V. Meyer and his pupils, is that derived from the hypothetical iodonium hydroxide, $IH_2.OH$. In these substances the iodine plays a part analogous to that of nitrogen or sulphur in the ammonium and sulphonium compounds. The curious and striking resemblance of the corresponding diphenyl iodonium and thallium salts is very suggestive.

Many of his investigations related to the connection between the constitution of a substance and the relative ease with which it entered into a given reaction. As examples may be mentioned his work on the influence of certain groups on the acid properties of substances containing them, and that on the relative ease of etherification of substituted benzoic acids, and on the formation of oximes or hydrazones of aromatic ketones.

Victor Meyer's best-known work is certainly that on vapour-density. A description of his air-displacement method of determining vapour-density is to be found in almost every text-book of chemistry, and a specimen of his apparatus in almost every laboratory in the world. The method was devised in 1878, and since then hardly a year has elapsed in which he has not described some improvement of the apparatus, rendering it capable of more extended usefulness or some results, frequently of the highest interest, obtained by means of it. It is not easy to realise how little we would know of the molecular condition of vapours, especially at high temperatures, if Meyer's work in this direction were swept away. In a fascinating paper published in 1890, entitled "Chemische Probleme der Gegenwart," he gives rein to his scientific imagination, and discusses what might occur if it were possible to carry out vapour-density determinations at temperatures as much above the highest now reached as the latter are above the ordinary temperature.

In recent years he paid much attention to the study of chemical change in gaseous systems. The investigation of the reaction between iodine and hydrogen is particularly noteworthy as affording one of the very few examples known of a normal reaction between gases.

As a lecturer, Victor Meyer was equally admirable. He had a wonderful power of rapidly presenting a subject clearly to his students, and, at the same time, of impressing fundamental conceptions on their minds. He was never dogmatic; if there were two views current on any subject he carefully explained both of them, leaving his hearers to form their own opinions. The bearing of chemistry on practical matters was not forgotten; for example, when dealing with sugar he sketched the development of the German beet-sugar industry, and gave an account of the legislation connected with sugar bounties and its economic consequences. The experimental illustration of his lectures was extremely complete and carefully prepared. This was not only the case with the lectures on inorganic, but also with those on organic chemistry, the number of substances prepared in the latter being quite astonishing. To make this possible in cases where, for example, a prolonged heating was necessary, the beginning of the reaction was shown in one experiment, the end of it in another, which had been started before the lecture.

The "Lehrbuch der Organischen Chemie," by Victor Meyer and Paul Jacobson, the first part of which appeared in 1891, is written with that freshness which is hardly possible without an intimate personal acquaintance with the subject. It is especially valuable in these latter days, when the writing of text-books by men who take a foremost part in investigation is not so common as in the time when Berzelius, Liebig, Gerhard and Kekulé wrote their classical works.

NOTES.

THE French Academy has just accepted the administration of M. Pierre Lasserre's legacy, now amounting to 576,450 francs. In accordance with the terms of the bequest, the capital sum will be divided in three parts, the interests upon which will be awarded to the author of the best literary work, for an important scientific discovery, and to the composer of the best musical work. The respective awards will be made by the French Academy, the Academy of Sciences, and the Academy of Fine Arts.

THE Council of the Society of Arts have appointed the following Committee to investigate the causes of the deterioration of paper: Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of the Council; Sir William Anderson, K.C.B., F.R.S., Mr. Michael Carteighe, Mr. C. F. Cross, Sir John Evans, K.C.B., F.R.S., Dr. Richard Garnett, C.B., Dr. Hugo Müller, F.R.S., Dr. W. J. Russell, F.R.S., Mr. W. L. Thomas, Prof. J. M. Thomson, F.R.S., Mr. Henry R. Tedder, Dr. Quirin Wirtz, Sir Henry Trueman Wood, Secretary. In the course of a circular letter which has been sent to those who are interested in the preservation of paper, it is pointed out that many books of an important character are now printed upon paper of a very perishable nature, so that there is considerable risk of the deterioration and even destruction of such books within a limited space of time. This is believed to be especially true of books which are in constant use for purposes of reference, and are therefore liable to much handling. Although a great deal of investigation has been made into the subject in Germany, the matter appears to have attracted but little attention in this country. The Council of the Society of Arts therefore readily acceded to a proposal made to them, and appointed a Committee to inquire into and report upon the whole subject.

AT Crevalcore, a small town situated on the outskirts of Bologna, there was to be unveiled yesterday, September 8, a bronze monument erected in honour of Marcello Malpighi, the celebrated Italian anatomist, botanist, and microscopist, the contemporary, amongst others, of Hooke, Grew, and Oldenburg, names famous in the early annals of our Royal Society. Malpighi's relations, indeed, with that Society were close and cordial throughout. His interesting correspondence with Henry Oldenburg, its first Secretary, and with men equally concerned in the "Improvement of Natural Knowledge," is carefully preserved in the Society's archives. Not only this, his autobiography, and many most important contributions to the anatomy of plants, and discoveries in physiology were published in London under the auspices of the Royal Society, notably "Anatome Plantarum" (1672), and "De Structura Glandularum conglobatarum" (1689), as well as his treatise on the Silkworm, "De Bombyce" (1669). On March 4, 1668, the Society elected Malpighi an honorary member, on the initiative of Oldenburg, and this compliment was in 1680 gracefully acknowledged by Malpighi in the shape of a present of his own portrait. In addition to the inauguration of a monument there will appear at Milan, almost immediately, "Malpighi e l' Opera sua," edited by Doctor Vallardi. Contributions to the volume have been

made by Profs. Strasburger, Virchow, Haeckel, Kölliker, Weiss, and others, while Prof. Michael Foster, Sec.R.S., furnishes a note; and it will also include several hitherto unpublished letters between Malpighi and the Royal Society. A commemorative medal has been struck, bearing on the obverse the profile effigy of the anatomist, and date. The reverse has an oak garland with inscribed legend, "It fama per orbem." The programme of Wednesday's celebration included a "Commemorazione malpighiana" by Prof. Romiti, held at the Teatro Comunale, and a special performance of Massenet's "Manon." The Royal Society sent an address of congratulation to the President of the Committee. It nominated Dr. D. H. Scott, F.R.S., honorary keeper of the Jodrell Laboratory at Kew Gardens, as its representative, but at the last moment Dr. Scott was prevented by sudden indisposition from attending.

THE German Pharmaceutical Association has awarded the first Flückiger Memorial Medal to Mr. E. M. Holmes, Curator of the Pharmaceutical Society's Museums, in recognition of his services to botany and pharmacognosy.

THE eleventh International Congress of Orientalists opened at Paris on Monday, under the presidency of M. Rambaud, the French Minister of Public Instruction.

THE collections, notes, and apparatus of the Zoological Expedition sent by Columbia University to Alaska have all been lost in the *City of Mexico*, which was wrecked while attempting to enter Queen Charlotte Sound on August 4. The members of the expedition were rescued from the ship, but the results of their season's work have been entirely lost.

WE regret to announce the deaths of Mr. William Archer, F.R.S., librarian of the National Library of Ireland; Dr. T. Bogomoloff, professor of medical chemistry in the University of Kharkoff; Dr. John Braxton Hicks, F.R.S., one of the pioneers of British work on diseases of women, and a Fellow of the Royal Society since 1862.

THE *Lancet* announces the death of Dr. Holmgren, professor of physiology in the University of Upsala. Dr. Holmgren was born in 1831, and worked for many years under Brücke, Du Bois Reymond, and Helmholtz. He was appointed to the chair of Physiology in 1864, and had the honour of establishing the first physiological institute in Sweden. He was chiefly known in this country from his researches on colour-blindness and his plan of testing the colour sense by means of wools.

THE forty-second annual exhibition of the Royal Photographic Society is now in course of preparation. It will be opened to the public on Monday, September 27, and the Saturday previous there will be a private view, followed in the evening by a conversazione at which the President, the Earl of Crawford, K.T., F.R.S., and Council will receive the Fellows, Members, and their friends. The exhibition will be open daily from 10 to 5, and on Monday, Wednesday and Saturday evenings (when lantern slides will be shown) from 7 to 10; and will close on November 13.

AT the final meeting of the International Medical Congress at Moscow on August 26, the first award of the international prize instituted by the City of Moscow was made to M. Henri Dunant, of Geneva, for the services he has rendered to humanity in the part he has played in founding the Red Cross Societies. This triennial prize, to be awarded by successive international congresses, either for the best work upon medicine or hygiene, or for eminent services rendered to suffering humanity, will amount to 5000 francs (200*l*.), representing the interest at 4 per cent. on the capital of 16,450 roubles voted by the municipality.

IT is stated that a large quantity of instruments have arrived at Dover for use in connection with some experiments in telegraphing without wires. The arrangements include experiments from Fort Burgoyne to the north of Dover Castle and other parts of the surrounding country, which offers facilities for work of this character. From the results which have been attained elsewhere it is believed the system can be successfully applied to lightships. From the position at Dover the Goodwin lightships will be made the objects of experiments under the direction of Mr. W. H. Preece. The sending apparatus will be at Fort Burgoyne, and the receiving apparatus will be moved to different parts of the district.

MOST of the subjects of address and papers brought before the meeting of the British Medical Association at Montreal were of too technical a character to be usefully chronicled in these columns. On Wednesday, September 1, the eleven sections met in the several rooms assigned to them. In the section of Medicine, Dr. Stephen Mackenzie delivered an address on the influences that have determined the progress of medicine during the preceding two and a half centuries. Mr. Christopher Heath opened the proceedings in the section of Surgery by the delivery of an address on the teaching of surgery. In the section of Public Medicine the proceedings were opened by Dr. E P. Lachapelle, who described the progress in sanitation that had been effected in Canada down to the present time. Dr. R. M. Bucke, of London, Ontario, delivered the presidential address in the section of Psychology, on the evolution of the human mind since the days of prehistoric man. Among other addresses was one on "British Medicine in Greater Britain," by Dr. William Osler; "The Surgeon of Old in War," by Dr. W. Mitchell Banks, and "On the Progress and Results of Pathological Work," by Prof. W. Watson Cheyne. The meeting was brought to a close on September 3, with an address by Dr. Herman Biggs on the working of the health department of New York City, and the efforts made by that body to stamp out consumption. The social side of the meeting was very successful, both the members of the medical profession and private citizens displaying lavish hospitality. The Canadians appear to have done everything in their power to make this, the first meeting of the Association outside the United Kingdom, one of exceptional brilliancy in every respect. The McGill University conferred the honorary degree of Doctor of Laws on Lord Lister, Prof. Richet, Sir William Turner, Dr. Henry Barnes, Dr. Michael Foster, Dr. W. H. Gaskell, Mr. Christopher Heath, Prof. Alexander Macalister, Dr. R. Saundby, and Mr. C. G. Wheelhouse. A speech was made by Lord Aberdeen in his capacity as visitor of the University. Lord Lister, Prof. Richet, and Dr. Michael Foster returned thanks in suitable terms.

A FINE waterspout was seen off Cromer on Saturday last. Sir William Flower, who saw it from New Haven Court, says that the whole phenomena consisted of two distinct portions (1) The real waterspout; a column of water, soon dissipated into steam, rising from the sea, and caused, apparently, by a violent and greatly concentrated cyclonic action of the air. (2) A greatly elongated portion of the lower edge of an extremely dense black cloud which was hanging just over it attracted into the vortex. The two travelled along together in the direction of the prevailing wind, but the apex of the descending prolongation of the dark cloud always pointed to the centre of the ascending column, though its length, form, and direction varied from time to time.

SEVERAL sensational paragraphs have appeared in the daily press during the past few months as to an alleged method of converting silver into gold, said to have been discovered by Dr.

Stephen H. Emmens. From a letter by Dr. Emmens in the current number of the *Chemical News*, we understand he does not claim to be a modern alchemist, but merely to be able to obtain gold, or a substance which will pass muster for gold, from Mexican dollars. Four Mexican dollars were cut in halves at the U.S. Assay Office, at the request of Dr. Emmens, and four halves were assayed at the Office, with the result that no gold was found—at least, the amount was less than one part in ten thousand. The remaining set of halves of the coins "was treated in the Argentaurum Laboratory, without the addition of gold in any form, and the result was a relatively considerable production of a metal which answered to all the usual tests of gold, and was subsequently purchased as gold by the U.S. Assay Office." The weight of the gold obtained is not stated. Of course, it is possible to make the gold found the basis of very untrustworthy statements, and that appears to have been done. Apparently, however, Dr. Emmens disclaims responsibility of the newspaper reports, for what he now concludes is:—"Either some of the silver or copper in the dollars had been changed into gold or its simulacrum by my treatment; or the gold already existed in the dollars and was separated by my treatment, though not by the treatment in vogue at the U.S. Assay Office." Sir William Crookes has examined a specimen of argentaurum in the spectrograph; and he finds that it consists of gold with a fair proportion of silver and a little copper. No lines belonging to any other known element, and no unknown lines, were detected.

The deaths from lightning in this country are, happily, very few, being only about 1 per million of the population per annum. Sometimes no sign of injury can be seen upon the victim, but in other cases marks are left upon the body, or clothes are scorched, and more than one case has been recorded where boots have been torn off the feet and nails driven out of the soles of the boots. Seldom, however, does it happen that lightning leaves such remarkable evidence of its transit as that disclosed at an inquest recently held at Hulford House, near Guildford, and reported in the *Lancet*. The evidence showed that on Wednesday, August 25, there had been a single flash of lightning and a clap of thunder, and about half an hour afterwards Major Jameson was found lying on his face in a field quite dead. Around him, in a radius of several yards, were his clothes and boots, which had been torn and scattered about in an extraordinary manner. The lightning appears to have struck him on the right side of the head, tearing his cap to pieces and burning his hair off. It then passed inside his collar down the front of his body and both legs into his boots, which were torn to pieces, and then passed into the ground, making a hole about eighteen inches in circumference and three inches deep. His collar was torn to pieces, the front of his shirt was rent into ribbons, the jacket and under-vest were literally torn to shreds, and the knickerbockers he was wearing were stripped from him and scattered on the ground. His stockings and gaiters were similarly torn in pieces, and on the boots the lightning had a remarkable effect. They were burst open, some of the brass eyelet-holes were torn out, nails were forced out, and the soles torn off. The skin had been torn off the chest, and the right leg was torn and blackened; blood was issuing from the mouth and right ear. It is difficult to account for these appalling effects, or to explain why the electric discharge should produce widely different results upon different occasions.

Dr. G. Hellman, whose facsimile reproductions of old meteorological works are well known in this country, contributes to the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* a short paper on the beginnings of observations of terrestrial magnetism. He traces the earliest observations of magnetic declination along two distinct lines: one due to the interest excited amongst seamen by Columbus's discovery, on September 13, 1492, of the changes in the variation of the compass, and another due to landsmen's efforts to construct an accurate portable sundial. A list of ten determinations of magnetic declination is given, beginning with Georg Hartmann at Rome about 1510 (6° E.), and ending with Gerhard Mercator on the island of Walcheren about 1546. The work of the remarkable João de Castro seems by far the best: he gives decl. 7½° E. at Lisbon in 1538. The first English observations are those of William Borough, of Limehouse, published in his "Discourse of the Variation of the Compass or Magnetical Needle," &c., in the year 1581, now a very rare book.

We have received from M. Durand-Gréville a paper entitled "Les grains et le burster d'Australie," being an excerpt from the *Annales* of the French Meteorological Office for 1895 (just published). This is one of a series of valuable discussions on violent squalls in various parts of the world, which it is the aim of M. Durand-Gréville to show are very similar in their nature, although differing in their name and in their secondary characteristics (temperature, humidity, &c.). He points out that there are two different kinds of barometric depressions: (1) where the variations of pressure, temperature, &c., are gradual; and (2) where these elements change abruptly along a radial line running nearly to the southwards. In the rear of the passage of this radial line from west to east an area of high pressure and violent winds obtain. It is to this special feature that M. Durand-Gréville has paid particular attention, and his views seem to be consistent with those adopted by investigators in this country and in Germany, when dealing with secondary and especially the so-called V-shaped depressions, which often accompany or immediately follow a primary atmospherical disturbance.

Prof. Dr. Johan Hjort publishes in *Naturen* a more or less popular *résumé* of some of the recent physical and biological researches in the Norwegian Sea. The most important work not published before consists of a discussion of two extremely valuable sets of temperature and salinity observations made between Norway and Iceland during March and April 1897. These serve to show the form and extent of the cold streams from the east of Iceland at a time when it is rarely possible to get any information, precisely the time when that information is of the highest importance.

M. E. A. Martel gives, in the *Comptes rendus de la Société de Geographie*, a summary of his work in Speleology during 1896. Six series of caverns were explored in France, two in the Island of Majorca, and the famous Salitre grotto in Catalonia. The Foiba de Pisino in Istria, visited in 1893, was re-examined, and some remarkable observations made on the changes produced in a subterranean lake by continued heavy rains. Under certain conditions the hydrostatic pressure in the underground syphon feeding the Foiba must amount to at least seven atmospheres, doubtless producing important mechanical and chemical changes.

Dr. Rudolf Zuber, professor of geology in the University of Lemberg, has recently published a map of the petroleum region of Galicia, with a paper, in the German language, on the economical geology of the district. As he points out in the introduction to his paper, the region is one of surpassing geological interest and difficulty, while the language offers a greater barrier, both to travel and to a study of the literature, than is the case in many regions much further afield. Dr. Zuber's paper is therefore all the more welcome. It contains a classification of the oil-bearing strata based upon local characteristics, which amply serves the purposes of the local industry without

committing itself upon the much more difficult question of their precise age.

IN a previous note in NATURE (p. 205), attention was called to Dr. Giovanni Vailati's studies on the statical notions of Archimedes. We have now received a reprint of a further paper by the same writer (*Atti della R. Accademia delle Scienze di Torino*, xxxii.), dealing with the "Principle of Virtual Work from Aristotle to Hero of Alexandria." From an examination of the *Mechanika Problemata* of Aristotle, the *Baroulkos* of Hero, and a Latin thirteenth century manuscript, *De ponderibus*, attributed to Giordano Nemorario, it appears that this principle, though commonly supposed to have been discovered about the end of the fifteenth century, was in reality known to the Greeks. In the work of Hero, Dr. Vailati finds not only distinct statements of the relations between forces and the displacements produced by them, but also applications of the principle to various machines, including pulleys. From this evidence the author attributes to the Greeks a knowledge of the subject considerably in advance of that evinced by the sixteenth-century writers on statics.

A PHOTO-VOLTAIC theory of photographic processes forms the subject of a lengthy investigation, by H. Luggin (*Zeitschrift für physikalische Chemie*, xxiii. 4). It was shown by Becquerel, in 1839, that the haloids of silver are capable, under certain conditions, of giving rise to photo-voltaic currents; and Herr Luggin finds a close connection between these currents and the decompositions which give rise to photographs. A remarkable feature is the reversal of the voltaic current which occurs when a certain potential has been reached, a consequence of which is that the same electrode is capable, according to circumstances, of giving rise to currents of opposite signs, and these Herr Luggin distinguishes as "normal" and "solarisation currents." The former are the more susceptible to blue, and the latter to yellow light. The whole investigation tends to throw light on the much-debated theories of photographic action, by showing that both the latent picture of photographic negatives and the visible transformations of the printing-out process have their counterpart in definite photo-voltaic phenomena.

AN interesting account of the earthquake of Aïdin (Asia Minor) on August 19, 1895, is given by Dr. G. Agamennone in Gerland's *Beiträge zur Geophysik*. The epicentre is situated at or close to the village of Imamkeuy, which is 6 km. east of Aïdin, and the majority of damaged buildings lie within an area about 50 km. long and 20 km. broad, the longer axis of the area being roughly parallel to the valley of the Menderes. The disturbance was registered by the Vicentini microseismograph at Padua (1570 km. from the origin), and the horizontal pendulum at Strassburg (2010 km.). The usual secondary phenomena, such as landslips, fissures in the ground, and the derangement of the underground water-system, occurred in the epicentral area; and some of the landslips gave rise to thick clouds of dust, which hung in the air for several hours, and were then carried by the wind to the south side of the valley and deposited on the adjoining mountains.

WE have heard often enough that loud and continued explosions produce rain, and the recollection of rain-making experiments based upon this apparent connection is still with us. Now comes a report from Mr. Germain, United States Consul at Zürich, on the prevention of hailstorms by the same means that have been used to encourage a downfall of rain. It appears that Mr. Albert Stiger, burgomaster of Windisch-Freistritz (Lower Steirmark, Austria), owns extensive vineyards situated on the southern slopes of the Bacher Mountains, a locality often visited by destructive hailstorms. To protect his vines from hail, he decided to try the shooting or explosive system to scatter the clouds and drive away approaching hail or heavy rain storms. Six stations were therefore erected on the six most prominent summits surrounding the locality, and commanding a territory of about two miles in extent. These stations sheltered ten heavy mortars each. Upon the slightest indication of a storm the mortars were immediately manned and loaded with 120 grams of powder each—about 4¼ ounces—and shooting commenced simultaneously and continued regularly out of the sixty mortars until the clouds were scattered and the storm had blown over. These experiments were anxiously watched by the citizens of Windisch-Freistritz last summer. Threatening black clouds made their appearance over the summits of the Bacher Mountains; at a given signal all the mortars were fired off, and the continuous detonations in a few moments caused a sudden reaction in the movements of the clouds. It is said that the cloud opened up funnel-like, the mouth of the funnel began to rise in the form of consecutive rings, expanding gradually until all of the cloud scattered and entirely disappeared. There was no hail, or even a sudden downpour of rain. The same experience was gone through six times during the summer, and proved a successful preventive in each case. We await the views of Austrian meteorologists upon these experiments; meanwhile, rain-makers who have put their trust in explosions must hide their diminished heads before the rain-dispersers.

IT has long been known that in the Pondicherry district of Peninsular India there occur Cretaceous rocks with a peculiar fauna, but though studied by such palæontologists as Forbes, d'Orbigny, and Stoliczka, the exact horizon of these beds has remained uncertain, they having been variously placed in the lower, the middle, and the upper parts of the Cretaceous system. This question may be taken as finally settled by Dr. F. Kossmatt (*Records Geol. Survey India*, xxx. 2, May 1897), who, applying the increased modern knowledge of the succession of life-forms in the Cretaceous to these beds, divides them into three divisions, of which the two lower represent the Upper Senonian (highest part of the English chalk) and the upper the Danian. The general interest of Dr. Kossmatt's paper lies, however, in the side-issues which it raises. Similar beds are known in Natal, Madagascar, Assam, Borneo, Yesso, Vancouver and Quiriquina Island, Chili. The similarity of the fauna in these beds shows the Pacific Ocean to have formed a well-defined province in Cretaceous times, separated by a barrier from the Mediterranean Ocean which extended through Europe and Central Asia. Somewhere in the Atlantic area, however, this barrier was imperfect, and a migration of Pacific forms into the Mediterranean took place, and a reverse migration to a smaller extent. By a careful study of these forms, Dr. Kossmatt arrives at a number of interesting conclusions: (1) The time required for the dispersal of a species was insignificant beside the time required for a measurable amount of sedimentation, so that in this case homotaxis means contemporaneity. (2) As the Ammonites were dispersed, they underwent definite specific changes, so that their wide distribution as fossils cannot be explained as the result of the flotation of their *dead* shells, as has been suggested by Dr. Walther. (3) The Ammonites seem to have possessed greater capacity for distribution than other groups. (4) The appearance of a new fauna in several cases coincides, everywhere, with an overlap, indicating an extension of the ocean over the land-surface: this repeated "positive displacement" of shore-lines is as characteristic of the Cretaceous all over the world, as the opposite displacement is of the beginning of the Tertiary; the Pondicherry beds, for example, rest directly on the Archæan crystallines of the Peninsula.

THE latest number of the *Journal* of the Asiatic Society of Bengal (vol. lxv. part II. No. 1, 1897, p. 345) is entirely taken up with the ninth descriptive catalogue of "Materials for a

Flora of the Malayan Peninsula," by Dr. George King, F.R.S. The publication of these very valuable contributions to botanical science was commenced more than seven years ago, but pressure of other work has prevented Dr. King from making as rapid progress as he desired. In the present part the account of the Calyciflorae is begun, and it is hoped that one more contribution similar in size to that just published will suffice to complete the Calyciflorae, and bring the whole series about half-way towards completion.

DURING the Norwegian North-Atlantic Expedition (1876-78), Prof. G. O. Sars collected from the surface a quantity of plankton containing many algæ, especially Diatoms. He described the most characteristic forms, and early last year handed over the samples for more detailed study to H. H. Gran, whose description of the material has now been published in Memoir xxiv. of the "General Report of the Norwegian North-Atlantic Expedition" (Christiania: Grondahl and Sons), printed in both Norse and English. The study of the material shows that the water of the Atlantic is especially characterised by *Chætoceros decipiens*, *atlanticum*, *boreale* and *Brightwellii*, and by several *Rhizosolenia* species. The water of the Polar Sea during summer is characterised by *Chætoceros furcellatum*, *Fragilaria oceanica*, and *Thallassiosira* species. From the contents of the samples, however, no decided boundary could be drawn, either because the ocean currents mix to a certain extent with one another, or because the Diatomaceæ have the power of rising or sinking from one stratum of water to another, independently of the currents. Mr. Gran states that he has obtained evidence which clearly points to the occurrence of the latter possibility.

THE following are among noteworthy papers and other publications which have been received during the past few days:—The letters exchanged between the two mathematicians Jakob Steiner and Ludwig Schläfli from the year 1848 to 1856 are printed in the *Mittheilungen der Naturforschenden Gesellschaft in Bern* (1896), edited by Prof. J. H. Graf.—Mr. Bernard Quaritch has just issued two catalogues (Nos. 170, 172) of scientific books, and Transactions of learned societies, offered for sale by him. We notice in the list a set of *Challenger* Expedition Reports for sale for 67*l.* 10*s.* Scientific book-buyers and librarians should certainly see Mr. Quaritch's catalogues.—Part v. of "Fresenius' Quantitative Analysis" (vol. ii.), translated by Mr. Chas. E. Groves, F.R.S., has just been published by Messrs. J. and A. Churchill.

THE additions to the Zoological Society's Gardens during the past week include a Huanaco (*Lama huanacos*, ♀) from Bolivia, presented by Mr. W. J. Huxley; a —— Mouse (*Phyllotis griseoflavus*), two Chimachima Milvagos (*Milvago chimachima*), three Pileated Song Sparrows (*Zonotrichia pileata*), three Yellowish Finches (*Sycalis luteola*), two Bay Cow Birds (*Molothrus badius*), a Yellow Troupial (*Xanthosomus flavus*) from Argentina, three West African Love Birds (*Agapornis pullaria*) from West Africa, presented by Mr. E. A. Fitzgerald; a Malabar Squirrel (*Sciurus maximus*) from India, presented by Mr. J. E. Summers; two Rough-legged Buzzards (*Archibuteo lagopus*), European, presented by Mr. H. W. Feilden; a European Tortoise (*Emys orbicularis*) European, presented by Mr. Duncan Dickens; eleven Green Lizards (*Lacerta viridis*), two Sand Lizards (*Lacerta agilis*), a Wall Lizard (*Lacerta muralis*), European, presented by Mr. C. W. Tytheridge; a Crested Porcupine (*Hystrix cristata*), three White Storks (*Ciconia alba*), a Greater Black-backed Gull (*Larus marinus*), a Herring Gull (*Larus argentatus*), a Common Night Heron (*Nycticorax griseus*), two Buzzards (*Buteo vulgaris*), European, two Ypecaha Rails (*Aramides ypecaha*) from South America, deposited; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DEDICATION OF THE YERKES OBSERVATORY.—The formal dedication of the Yerkes Observatory will take place on October 21-22, and not on October 1, as previously announced. In connection with the dedication, a series of conferences on astronomical and astrophysical subjects will be held at the observatory on October 18, 19, 20, and 21. The provisional programme for these meetings is published in the August number of the *Astrophysical Journal*.

SOUTHERN DOUBLE STARS.—Profs. W. H. Pickering and S. I. Bailey have taken advantage of the steady air of Arequipa, and the consequent good definition, to search for close double stars in the southern skies. All the stars of the sixth magnitude and brighter, south of declination −30°, have been examined for close companions, with the 13-inch Boyden telescope. Nearly one hundred and fifty stars were thus found to have companions at distances not exceeding thirty seconds of arc, not counting stars already announced as double in the catalogues of Herschel and Russell. The numbers of these stars in the Argentine General Catalogue are recorded in *Harvard College Observatory Circular*, No. 18.

VARIABLE STARS IN CLUSTERS.—The important fact that a large number of individual stars in certain globular star clusters are variable, sometimes to the extent of two magnitudes or more, was announced in *Harvard College Observatory Circular* (No. 2) in November 1895 (see NATURE, vol. liii. p. 91), and was again referred to in May 1896 (NATURE, vol. liv. p. 108). A *Circular* (No. 18) just received from the observatory, announces that Prof. S. I. Bailey has found many more of these, bringing their total number up to 310. The greatest number of variables occur in the cluster No. 5272 in the New General Catalogue (Messier 3), as many as 113 stars in this cluster having been found to fluctuate in light. In N.G.C. 5904 (Messier 5), 63 stars have been proved to be variable, and in N.G.C. 5139 (ω Centauri) 60 stars appear to undergo light-changes. It is remarkable that while in the cluster Messier 3 about one-ninth of the stars are variable, in other clusters, for instance the great cluster in Hercules (N.G.C. 6205), not a single variable was found out of nearly two thousand stars examined.

THE MAGNITUDES OF THE ASTEROIDS.—An interesting history of the asteroids and the questions to which they give rise, is given by Herr G. Huber in the *Mittheilungen der Naturforschenden Gesellschaft in Bern* for the year 1896. The mean magnitude at opposition of the first four hundred minor planets are tabulated in groups of fifty as follows, the column marked Mag. 8 including asteroids of magnitudes 8 to 8·9, while the column marked Mag. 9 includes all from magnitude 9 to mag. 9·9, and so on for other magnitudes.

Numbers of asteroids.	Brighter than Mag. 8	Mag. 8	Mag. 9	Mag. 10	Mag. 11	Mag. 12	Fainter than Mag. 12
1– 50	2	7	17	15	7	2	—
51–100	—	—	2	19	23	5	1
101–150	—	—	—	15	27	8	—
151–200	—	—	1	4	20	20	5
201–250	—	—	—	3	18	17	12
251–300	—	—	—	1	7	13	29
301–350	—	—	2	2	8	21	17
351–400	—	—	—	2	4	13	31
Total ...	2	7	22	61	114	99	95

The table shows clearly that the asteroids discovered in recent years, namely those from No. 200 to No. 400, are mainly of the twelfth magnitude, or even fainter than that.

A NEW NEBULA PHOTOGRAPH.—A brilliant picture of the nebula Herschel V 15 Cygni (No. 6992 in the New General Catalogue), reproduced from a photograph obtained by Dr. Isaac Roberts, F.R.S., with an exposure of 2h. 55m., appears in the September number of *Knowledge*. The nebula is a wave-like brush of light, measuring about eighty minutes of arc in length,

and presenting a torn appearance in places. Faint nebulous stars are immersed in the wave structure, and here and there the luminous material gives indications of condensation. Surrounding the nebula, and strewn over its surface are numerous stars, which are, however, apparently not physically connected with the general mass. Referring to the structure of the nebula in relation to the methods of stellar evolution, Dr. Roberts says:—"The general appearance of the nebula is that of precipitation of invisible matter—either gaseous or of dust particles —which exists in space as clouds of vast extent. . . . We know of no body whatever existing in space which has no motion of translation; but whether this invisible matter is in motion or at rest, it could be run into by another body that is in motion, with the result that whirlpool motions would be set up that would eventually develop into nebulæ of various forms, such as those which have already been, by photography, shown to exist. If, on the other hand, the clouds themselves are in motion and collide with each other, then vortical motion would be set up over large areas, giving rise by progress of development to such nebulæ as are represented by the photograph. This nebula shows signs of fission, and may pass in its process of development into symmetrical nebulæ and into stars, and again from stars into—what?"

A SUCCESSFUL EXPERIMENT IN LOBSTER-REARING.

ATTEMPTS to rear the larvæ of the lobster in this country have never hitherto succeeded. Several years ago Captain Dannevig reared some at Arendal, and published a description of his results, but no other instance of success with the European species has been recorded. In America the rearing of the American species has been successfully accomplished at Wood's Hole by Mr. F. H. Herrick, and a masterly description of the stages of the development, with extremely fine illustrations, was recently published by him as a number of the Fish Commission Bulletin. At the establishment of the Marine Biological Association at Plymouth attempts to rear lobster larvæ have been made, but never with success. In the tanks the larvæ invariably died after a few days, and when the hulk of a superannuated fishing-vessel was fitted up, provided with a well to which the water could have access, and moored in the Sound, she unfortunately sank at her moorings with the thousands of larvæ which she contained. It is therefore a fact not without interest and importance, that the difficult feat has been accomplished with some success during the present season at Falmouth. During the last two or three years, experiments in oyster and lobster culture have been carried on at that place under the auspices of a committee of the Royal Cornwall Polytechnic Society, the cost of the work being defrayed from a fund collected by private subscription, supplemented by grants from the Technical Instruction Committee. Until the commencement of this year the experiments were directed by Mr. Rupert Vallentin, who designed a large floating box 14 feet by 6 feet in area, by 3 feet in depth, provided with windows covered with metal gratings, for the purpose of rearing lobster larvæ. This box is moored in a corner of the docks where the water seemed quite pure. Last year no success was obtained, owing to an injury to the box. During the present season the experiments have been under the direction of Mr. J. T. Cunningham, the Lecturer on Fisheries for the county. Berried female lobsters were first placed in the box on and about June 24, to the number of three. Larvæ were first seen on July 6, and were fed on minced fish, but the number rapidly diminished. Seven more berried females were put in on July 16, and since that time there has always been a considerable number of larvæ alive in the box; some of the females have not yet hatched all their eggs (August 22). Since July 16 the only food supplied has been the crushed and pounded flesh of the edible crab, the females of which could be obtained regularly at small cost. It was found essential to feed the larvæ every day. As usual there was considerable mortality, and the larvæ showed their inveterate tendency to cannibalism; but a few specimens have passed through the various stages of their metamorphosis. Students of Herrick's memoir are aware that the final condition is reached, not considering certain minor features of little importance, at the fourth stage. The first stage is characterised by the entire absence of abdominal appendages, and the presence of the thoracic exopodites. After the second moult four pairs of abdominal pleopods are developed, at the third the uropods on the sixth abdominal somite are added, and at the fourth moult the exopodites are lost, and the antennary flagella appear. A specimen in the third stage was taken from the hatching-box at Falmouth on August 12, and one in the fourth stage on August 22.

The rearing of lobster larvæ may always remain too difficult and too expensive to be of any practical importance, and the survival of a single specimen may appear to be a small success. But there is every probability that other specimens will reach the same or later stages in the course of the experiment, and, considering the large amount of attention that the problem has attracted, the result above described is worthy of record.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. H. MARSHALL WARD, Sc.D., F.R.S., F.L.S., PRESIDENT OF THE SECTION.

THE competent historian of our branch of science will have no lack of materials when he comes to review the progress of botany during the latter half of the Victorian reign. The task of doing justice to the work in phanerogamic botany alone, under the leadership of men like Hooker, Asa Gray, Mueller, Engler, Warming, and the army of systematists so busily shifting the frontiers of the various natural groups of flowering plants, will need able hands for satisfactory treatment. A mere sketch of the influence of Kew, the principal centre of systematic botany, and of the active contingents of Indian and colonial botanists working under its inspiration, will alone require an important chapter, and it will need full knowledge and a wide vision to avoid inadequacy of treatment of its powerful stimulus on all departments of post-Darwinian botany. The "Genera Plantarum," the "British Flora," the "Flora of India," suffice to remind us of the prestige of England in systematic botany, and the influence of the large and growing library of local and colonial floras we owe to the labours of Bentham, Trimen, Clarke, Oliver, Baker, Hemsley, Brandis, King, Gamble, Balfour, and the present Director of Kew, is more than merely imperial.

The progress in Europe and America of the other departments of botany has been no less remarkable, and indeed histology and anatomy, comparative morphology, and the physiology and pathology of plants have perhaps advanced even more rapidly, because the ground was newer. In England the work done at Cambridge, South Kensington and elsewhere, and the publications in the "Annals of Botany" and other journals sufficiently bear witness to this. A consequence has been the specialisation which must soon be openly recognised—as it already is tacitly—in botany as in zoological and other branches of science.

No note has been more clearly sounded than this during the past twenty-five years, as is evident to all who have seen the origin, rise, and progress of our modern laboratories, special journals, and even the gradual subdivisions of this Association. We may deplore this, as some deplore the departure of the days when a naturalist was expected to teach geology, zoology, and botany as a matter of course; but the inevitable must come. Already the establishment of bacteriological laboratories and a huge special literature, of zymo-technical laboratories and courses on the study of yeasts and mould fungi, of agricultural stations, forestry and dairy schools, and so on—all these are signs of the inexorable results of progress.

There are disadvantages, as the various *Centralblätter* and special journals show; for hurried work and feverish contentions for priority are apt to accompany these subdivisions of labour; and those of us who are most intimately concerned with the teaching of botany will do well to take heed of these signs of our times, and distinguish between the healthy specialisation inevitably due to the sheer weight and magnitude of our subject, and that incident on other movements and arising from other causes. The teaching and training in a university or school need not be narrow because its research-laboratories are famous for special work.

One powerful cause of modern specialisation is utility. The development of industries like brewing, dyeing, forestry, agri-

culture, with their special demands on botany, shows one phase; the progress of bacteriology, palæontology, pathology, economic and geographical botany, all asking special questions, suggests another. In each case men are encouraged to go more and more deeply into the particular problems raised.

Identification of flowers in Egyptian tombs, of pieces of wood in Roman excavations, the sorting of hay-grasses for analysis, or seeds in the warehouses; the special classifications of seedlings used by foresters, or of trees in winter, and so on, all afford examples. It is carried far, as witness the immense labour it is found worth while for experts to devote to the microscopic analysis of seeds and fruits liable to adulteration, or to the recognition of the markings in imprints of fossil leaves, or of characters like leaf-scars, bud-scales, lenticels, and so on, by which trees may be determined even from bits of twigs.

If we look at the great groups of plants from a broad point of view, it is remarkable that the Fungi and the Phanerogams occupy public attention on quite other grounds than do the Algæ, Mosses, and Ferns. Algæ are especially a physiologists' group, employed in questions on nutrition, reproduction, and cell-division and growth; the Bryophyta and Pteridophyta are, on the other hand, the domain of the morphologist concerned with academical questions such as the Alternation of Generations and the Evolution of the higher plants.

Fungi and Phanerogams, while equally or even more employed by specialists in Morphology and Physiology, appeal widely to general interests, and evidently on the ground of utility. Without saying that this enhances the importance of either group, it certainly does induce scientific attention to them.

I need hardly say that comparisons of the kind I am making, invidious though they may appear, in no way imply detraction from the highest honour deservedly paid to men who, like Thuret, Schmitz, and Thwaites in the past, and Bornet, Wille, and Klebs in the present, have done and are doing so much to advance our academical knowledge of the Algæ; and Klebs' recent masterpiece of sustained physiological work, indeed, promises to be one of the most fruitful contributions to the study of variation that even this century has produced. Nor must we in England forget Farmer's work on *Ascophyllum*, and on the nuclei and cell-divisions of *Hepaticæ*; and while Bower and Campbell have laid bare by their indefatigable labours the histological details of the Mosses and Vascular Cryptogams, and carried the questions of Alternation of Generations and the evolution of these plants so far, that it would almost seem little remains to be done with Hoffmeister's brilliant conception but to ask whither it is leading us; the genetic relationships have become so clear, even to the details, that the recent discovery by Ikeno and Hirase of spermatozoids in the pollen tubes of *Cycas* and *Gingko* almost loses its power of surprising us, because the facts fit in so well with what was already taught us by these and other workers.

It is impossible to over-estimate the importance of these comparative studies, not only of the recent Vascular Cryptogams, but also of the Fossil Pteridophyta, which, in the hands of Williamson, Scott, and Seward, are yielding at every turn new building stones and explanatory charts of the edifice of Evolution on the lines laid down by Darwin.

All these matters, however, serve to prove my present contention, that the groups referred to do not much concern the general public; whereas, on turning to the Fungi and Phanerogams, we find quite a different state of affairs. It is very significant that a group like the Fungi should have attracted so much scientific attention, and aroused popular interest at the same time. In addition to their importance from more academical points of view—for they claim the attention of morphologist and physiologist as much as any group, as the work of Wager, Massee, Trow, Hartog, and Harper, and an army of continental investigators, with Brefeld, Von Tavel, Magnus, &c., at their head, has shown—the Fungi appeal to wider interests on many grounds, but especially on that of utility. The fact that Fungi affects our lives directly has been driven home, and whether as poisons or foods, destructive moulds or fermentation-agents, parasitic mildews or disease germs, they occupy more of public interest than all other Cryptogams together, the flowering plants alone rivalling them in this respect.

A marked feature of the period we live in will be the great advances made in our knowledge of the uses of plants. Of course, this development of Economic Botany has gone hand in hand with the progress of Geographical Botany and the extension of our planting and other interests in the colonies, but the useful applications of Botany to the processes of home industries are increasing also.

The information acquired by travellers exploring new countries, by orchid-collectors, prospectors for new fibres or india-rubber, or resulting from the experiences of planters, foresters, and observant people, living abroad, has a value in money which does not here concern us; but it has also a value to science, for the facts collected, the specimens brought home, the processes observed, the results of analyses, the suggestions gathered—in short, the puzzles propounded by these wanderers—all stimulate research, and so have a value not to be expressed in terms of money.

The two react mutually, and I am convinced that the stimulus of the questions asked by commerce of botanical science has had, and is having, an important effect in promoting its advance. The best proof to be given of the converse—that Botany is really useful to commerce—is afforded by the ever-increasing demands for answers to the questions of the practical man. At the risk of touching the sensibilities of those who maintain that a university should regard only the purely academical aspects of a science, I propose to discuss some cases where the reciprocal influences of applied, or useful, and purely academic or useless botany—useless because no use has yet been made of it, as some one has wittily put it—have resulted in gain to both. In doing this, I wish to clearly state my conviction that no scientific man should be guided or restricted in his investigations by any considerations whatever as to the commercial or money value of his results; to patent a method of cultivating a bacillus, to keep secret the composition of a nutritive medium, to withhold any evidence, is anti-scientific, for by the nature of the case it is calculated to prevent improvement—*i.e.* to impede progress. It is not implied that there is anything intrinsically wrong in protecting a discovery: all I urge is that it is opposed to the scientific spirit.

But the fact that a scientific spirit is found to have a commercial value also—for instance, Wehmer's discovery that the mould fungus, *Citryomyces*, will convert 50 per cent. of the sugar in a saccharine solution to the commercially valuable citric acid: or Matruchot's success in germinating the spores of the mushroom, and in sending pure cultures of that valuable agaric into the market—is no argument against the scientific value of the research. There are in agriculture, forestry, and commerce generally, innumerable and important questions for solution, the investigation of which will need all the powers of careful observation, industrious recording, and thoughtful deduction of which a scientific man is capable. But while I emphatically regard these and similar problems as worthy the attention of botanists, and recognise frankly their commercial importance, I want to carefully and distinctly warn all my hearers against supposing that their solution should be attempted simply because they have a commercial value.

It is because they are so full of promise as scientific problems, that I think it no valid argument against their importance to theoretical science that they have been suggested in practice. In all these matters it seems to me we should recognise that practical men are doing us a service in setting questions, because they set them definitely. In the attempt to solve these problems we may be sure science will gain, and if commerce gains also, so much the better for commerce, and indirectly for us. But that is not the same thing as directly interesting ourselves in the commercial value of the answer. This is not our function, and our advice and researches are the more valuable to commerce the less we are concerned with it.

It is clear that the magnitude of the subject referred to is far beyond the measure of our purpose to-day, and I shall restrict myself to a short review of some advances in our knowledge of the Fungi made during the last three decades.

Little more than thirty years ago we knew practically nothing of the life-history of a fungus, nothing of parasitism, of infectious diseases, or even of fermentation, and many botanical ideas now familiar to most educated persons were as yet unborn. Our knowledge of the physiology of nutrition was in its infancy, even the significance of starches and sugars in the green-plant being as yet not understood; root-hairs and their importance were hardly spoken of; words like *heterœcism*, *symbiosis*, *mycorhiza*, &c., did not exist, or the complex ideas they now connote were not evolved. When we reflect on these facts, and remember that *bacteria* were as yet merely curious "animalculæ," that rusts and smuts were generally supposed to be

emanations of diseased states, and that "spontaneous generation" was a hydra not yet destroyed, we obtain some notion of the condition of this subject about 1860.

As with other groups of plants, so with the Fungi, the first studies were those of collecting, naming and classifying, and prior to 1850 the few botanists who concerned themselves with these cryptogams at all were systematists. So far as the larger fungi are concerned, the classification attained a high degree of perfection from the point of view of an orderly arrangement of natural objects, and the student of to-day may well look back at the keen observation and terse, vivid descriptions of these older naturalists, which stands in sharp contrast to much of the more slovenly and hurried descriptive work which followed.

It may be remembered that even now we rely mainly on the descriptions and system of Fries (1821-1849) for our grouping of the forms alone considered as fungi by most people, and indeed we may regard him as having done for fungi what Linnæus did for flowering plants.

But, as you are aware, a large proportion of the Fungi are microscopic, and in spite of the conscientious and beautiful work of several earlier observers, among whom Corda stands pre-eminent, the classification and descriptions of the thousands of forms were rapidly bringing the subject into chaos.

The dawn of a new era in Mycology was preparing, however. A few isolated observers had already begun the study of the development of Fungi, but their work was neglected, till Persoon and Ehrenberg at the beginning of this century again brought the subject into prominence, and then came a series of discoveries destined to stimulate work in quite other directions.

The Tulasnes may be said to have brought the old period to a close, and prepared the way for the new one; they combined the powers of accurate observation with a marvellous faculty of delineation, and applied the anatomical method to the study of fungi with more success than ever before. Their new departure, however, is more evident in their selection of the parasitic fungi for study, and you all know how indispensable we still find their drawings of the germinating spores of the Smuts and Rusts. It is difficult to say which of their works is the most masterly, but probably the study of the life-history of *Claviceps purpurea* deserves first place, though successive memoirs on the Uredineæ, Ustilagineæ, Peronosporeæ, Tuberaceæ, and then that magnificent work, the "Selecta Fungorum Carpologia," cannot be forgotten.

In England, Berkeley was the man to link the period previous to 1860 with the present epoch. A systematist and observer of high power, and with a rare faculty for appreciating the labours of others, this grand old naturalist did work of unequalled value for the period, and the student who wishes to learn what was the state of mycology about this time will find it nowhere better presented than in Berkeley's works, one of which—his "Introduction to Cryptogamic Botany"—is a classic.

Like all classifications in botany, however, that of the fungi now took two courses: one in the hands of those who collated names and herbarium-specimens, and proposed cut and dried, but necessary and from a certain point of view very complete systems of classification, and those who, generalising from actual cultures and observation of the living plant, proposed outline schemes, the details of which should be filled in by their successors.

No one who knows the history of botany during this century will deny that it is to the genius of De Bary that we owe the foundation of modern mycology, for it was this young Alsatian who, though profoundly influenced by the work of Von Mohl and Schleiden on the one hand, and of Unger and the Tulasnes on the other, refused to follow either the school of the phytotomists—though his laborious "Comparative Anatomy of the Ferns and Phanerogams" shows how well equipped he was to be a leader in that direction—or that of the anatomical mycologists. No doubt the influence of Cohn, Pringsheim, and others of that new army of microscopists who were teaching the necessity of continued observation of living organisms under the microscope, can be traced in impelling De Bary to abandon the older methods; but his own unquestionable originality of thought and method came out very early in his investigations on the Lower Algæ and Fungi. If I may compare a branch of science to an arm of the sea, we may look on De Bary's influence as that of a Triton rising to a surface but little disturbed by currents and eddies. The sudden upheaval of his genius set that sea rolling in huge waves, the play of which is not yet exhausted.

The birth and flow of the new ideas, expressed in far-reaching generalisations and suggestions which are still moving, led to the revolutions in our notions of polymorphism, parasitism, and the real nature of infection and epidemics. His development of the meaning of sexuality in Fungi, his startling discovery of heterœcism, his clear exposition of symbiosis, and even his cautious and almost wondering whisper of chemotaxis were all fruitful, and although the questions of enzyme-action and fermentation were not made peculiarly his own, he saw the significance of these and many other phenomena now grown so important, and here, as elsewhere, thought clearly and boldly, and criticised fearlessly with full knowledge and justice.

I do not propose to occupy our time with even a sketch of the history of these and other ideas of this great botanist; but rather pass to the consideration of a few of the results of some of them in the hands of later workers, in schools now far developed and widely independent of one another, but all deeply indebted to the genial little man whom we so loved and revered.

The most marked feature noticed in the founding of the new schemes of classification of the Fungi was the influence of the results of pure and continuous cultures introduced by De Bary. The effect on those who followed can best be traced by examining the great systems of subsequent workers, led by Brefeld and Van Tieghem, and the writings of our modern systematists. This task is beyond my present scheme, however, and there is only time to remind you of the fungus floras of Saccardo, Constantin, Massee, and others, in this connection.

The word "fermentation" usually recalls the ordinary processes concerned in the brewing of beer and the making of wines and spirits; but we must not forget that the word connotes all decompositions or alterations in the composition of organic substances induced by the life-activities of Fungi, and that it is a mere accident which brings alcoholic fermentation especially into prominence.

I ventured some time ago to term alcoholic fermentation the oldest form of microscopic gardening practised by man, and this seems justified by what we know of the very various and very ancient processes in this connection.

But the making of beers, wines, and spirits, as we understand them, constitutes but a small part of the province of fermentation, and even when we have added cider and perry, ginger-beer, and the various herb and spruce beers to the list, we have by no means exhausted the tale of fermented drinks. Palm-wines of various kinds, toddy, pulque, arrack, kava, and a number of tropical alcoholic fermented liquors have to be included, and the koumiss and kephir of the Caucasus, the curious Russian kwass, the Japanese saké, and allied rice-preparations must be mentioned, to say nothing of the now almost forgotten birch-beer, mead and metheglin, and various other strange fermented decoctions of our forefathers' time, or confined to out-of-the-way localities.

In all these cases the same principal facts come out—a saccharine liquid is exposed to the destructive action of fungi, which decompose it, and we drink the altered or fermented liquor. As is now well known, the principal agents in these fermentations are certain lower forms of fungi called yeasts, and since Leeuwenhoeck, of Delft, discovered the yeast cells two hundred years ago, and La Tour, Schwann, and Kützing (about 1840) recognised them as budding plants, living on the sugar of the liquid, and which must be classed as Fungi, the way was paved for two totally different inquiries concerning yeast.

One of these was the fruitful one instigated by Pasteur's genius about 1860, and concerned the functions of yeast in fermentation. In the hands of Naegeli, Brefeld, and others abroad, and of A. J. and Horace Brown and Morris and others in England, Pasteur's line of research was rapidly developed, and, as we all know, has had a wide influence in stimulating investigation and in suggesting new ideas; and although the theory of alcoholic fermentation itself has not withstood all the criticism brought against it, and seems destined to receive its severest blow this year by E. Buchner's isolation of the alcoholic enzyme, we must always honour the school which nursed it.

The divergent line of inquiry turned on the origin and morphological nature of yeast. What kind of a fungus is yeast, and how many kinds or species of yeasts are there?

Reess, in 1870, showed the first steps on this long path of inquiry, and gave the name *Saccharomyces* to the fungus, showing that several species or forms existed, some of which develop definite spores.

In 1883, Hansen, of Copenhagen, taking advantage of the strict methods of culture introduced and improved by De Bary, Brefeld, Klebs, and other botanists, had shown that by cultivating yeast on solid media from a single spore it was possible to obtain constant types of pure yeasts, each with its own peculiar properties.

One consequence of Hansen's labours was that it now became possible for every brewer to work with a yeast of uniform type instead of with haphazard mixtures, in which serious disease forms might predominate and injure the beer. Another consequence soon appeared in Hansen's accurate diagnosis of the specific or varietal characters of each form of yeast, and among other things he showed that a true yeast may have a mycelial stage of development. The question of the nucleus of the yeast-cell, on which Mr. Wager will enlighten us, has also occupied much attention, as have also the details of spore formation.

Meanwhile, a question of very general theoretical interest had arisen.

Reess, Zopf, and Brefeld had shown that many higher fungi can assume a yeast-like stage of development if submerged in fluids. Various species of *Mucor*, *Ustilago*, *Exoascus*, and as we now know, numerous Ascomycetes and Basidiomycetes as well, can form budding cells, and it was natural to conclude that probably the yeasts of alcoholic fermentation are merely reduced forms of these higher fungi, which have become habituated to the budding condition—a conclusion apparently supported by Hansen's own discovery that a true *Saccharomyces* can develop a feeble but unmistakable mycelium.

With many ups and downs this question has been debated, but as yet we do not know that the yeasts of alcoholic fermentations can be developed from higher fungi.

During the last two years it appeared as if the question would be settled. Takamine stated that the *Aspergillus* used by the Japanese in brewing saké from rice develops yeast-like cells which ferment the sugar derived from the rice. Jühler and Jorgensen then extended these researches and claimed to have found yeast-cells on other forms of fungi on the surface of fruits, and to have established that they develop endogenous spores—an indispensable character in the modern definition of the genus *Saccharomyces*—and cause alcoholic fermentation.

Klöcker and Schiönning have this last year published the results of their very ingenious and thorough experimental inquiry into this question, and find, partly by pure cultures of the separate forms, and partly by means of excellently devised cultures on ripening fruits still attached to the plant, but imprisoned in sterilised glass vessels, that the yeasts and the moulds are separate forms, not genetically connected, but merely associated in nature, as are so many other forms of yeasts, bacteria and moulds.

It is interesting to notice how here, as elsewhere, the lessons taught by pure cultures are found to bear fruit, and how Hansen's work justifies the specialist's laboratory.

Among the most astonishing results that have come to us from such researches are Hansen's discoveries that several of the yeasts furnish quite distinct races or varieties in different breweries in various parts of the world, and it seems impossible to avoid the conclusion that their race characteristics have been impressed on the cells by the continued action of the conditions of culture to which they have so long been exposed—they are, in fact, domestic races.

Much work is now being done on the action of the environment on yeasts, and several interesting results have been obtained. One of the most striking examples is the fact observed by Sauer, who found that a given variety of yeast, whose activity is normally inhibited when the alcohol attains a certain degree of concentration in the liquid, can be induced to go on fermenting until a considerably higher proportion of alcohol is formed if a certain lactic-acid bacterium is added to the fermenting liquor. The bacterium, in fact, prepares the way for the yeast. Experiments have shown that much damage may be done to beers and wines by foreign or weed germs gaining access with the yeasts, and Hansen has proved that several yeasts are inimical to the action of the required fermentation. But not all pure fermentations give the desired results: partly because the race-varieties of even the approved yeasts differ in their action, and partly, as it appears, on account of causes as yet unknown.

There are facts which lead to the suspicion that the search for the best possible variety of yeast may not yield the desired results, if this particular form is used as a pure culture. The researches of Hansen, Rothenbach, Delbrück, Van Laer, and others, suggest that associated yeasts may ferment better than any single yeast cultivated pure, and cases are cited where such a symbiotic union of two yeasts of high fermenting power has given better results than either alone.

If these statements are confirmed, they enhance the theoretical importance of some investigations I had made several years previously. English ginger-beer contains a curious symbiotic association of two organisms—a true yeast and a true bacterium—so closely united that the yeast-cells imprisoned in the gelatinous meshes of the bacterium remind one of the gonidia of a lichen entangled in the hyphæ of the fungus, except that there is no chlorophyll. Now it is a singular fact that this symbiotic union of yeast and bacterium ferments the saccharine liquid far more energetically than does either yeast or bacterium alone, and results in a different product, large quantities of lactic and carbonic acids being formed, and little or no alcohol.

In the kephir used in Europe for fermenting milk, we find another symbiotic association of a yeast and a bacterium; indeed, Freudenreich declares that four distinct organisms are here symbiotically active and necessary, a result not confirmed by my as yet incomplete investigation. I know of at least one other case which may turn out to be different from either of the above. Moreover, examples of these symbiotic fermentations are increasing in other directions.

Kosai, Yabe, and others have lately shown that in the fermentations of rice to produce saké, the rice is first acted on by an *Aspergillus*, which converts the starch into sugars, and an associated yeast—hitherto regarded as a yeast-form of the *Aspergillus*, but, as already said, now shown to be a distinct fungus symbiotically associated with it—then ferments the sugar, and other similar cases are on record.

Starting from the demonstrated fact that the constitution of the medium profoundly affects the physiological action of the fungus, there can be nothing surprising in the discovery that the fungus is more active in a medium which has been favourably altered by an associated organism, whether the latter aids the fungus by directly altering the medium, or by ridding it of products of excretion, or by adding some gas or other body. This granted, it is not difficult to see that natural selection will aid in the perpetuation of the symbiosis, and in cases like that of the ginger-beer plant it is extremely difficult to get the two organisms apart, reminding us of the similar difficulty in the case of the soredia of Lichens. Moreover, experiments show that the question of relative abundance of each constituent affects the matter.

I must now return for a moment to Buchner's discovery that by means of extremely great pressures a something can be expressed from yeast which at once decomposes sugar into alcohol and carbon-dioxide, and concerning which Dr. Green will inform us more fully. This something is regarded by Buchner as a sort of incomplete protoplasm—a body composed of proteid, and in a structural condition somewhere between that of true soluble enzymes like invertin and complete living protoplasm.

If this is true, and Buchner's *zymase* turns out to be a really soluble enzyme, the present theory of alcoholic fermentation will have to be modified, and a reversion made towards Traube's views of 1858, a reversion for which we are in a measure prepared by Miquel's proof in 1890 that *Urase*, a similar body extracted from the urea-bacteria, is the agent in the fermentation of urea. At present, however, we are not sufficiently assured that the body extracted by Buchner is really soluble, and I am told that very serious difficulties still face us as to what solution is. The enormous pressures required, and the fact that the "solution" coagulates as a whole, might suggest that he was dealing with expressed protoplasm, still alive, but devoid of its cell-wall; against this, however, must be urged the facts that the "solution" can be forced through porcelain and still act, and this even in the presence of chloroform.

We may fairly expect that the further investigation of Buchner's "zymase," Miquel's "urase," and the similar body obtained by E. Fischer and Lindner from *Monilia candida* will help in deciding the question as to the emulsion theory of protoplasm itself.

In any case, soluble or not, these enzymes are probably to be regarded as bits off the protoplasm, as it were, and so the essentials of the theory of fermentation remain, the immediate machinery being not that of protoplasm itself, but of something made by or broken off from it. Enzymes, or similar bodies,

are now known to be very common in plants, and the suspicion that fungi do much of their work with their aid is abundantly confirmed.

Payen and Persoz discovered diastase in malt extract in 1833, and in 1836 Schwann discovered peptase in the juices of the animal stomach. Since that time several other enzymes have been found in both plants and animals, and the methods for extracting them and for estimating their actions have been much improved, a province in which Horace Brown, Green, and Vines have contributed results.

It seems not improbable that there exists a whole series of these enzymes which have the power of carrying over oxygen to other bodies, and so bringing about oxidations of a peculiar character. These curious bodies were first observed owing to studies on the changes which wine and plant juices undergo when exposed to the action of the oxygen of the air.

In the case of the wine certain changes in the colour and taste were traced to conditions which involved the assumption that some body, not a living organism, acts as an oxygen-carrier, and the activity of which could be destroyed by heating and antiseptics. It was found that similar changes in colour and taste could be artificially produced by the action of ozone, or by passing an electric current through the new wine; indeed, it is alleged that the ageing of wine can be successfully imitated by these devices, and is actually a commercial process.

The browning of cut or broken apples is now shown to be due to the action of a similar oxydase—*i.e.* an oxygen-carrying ferment, and the same is claimed for the deep-colouring of certain lacks, or lackers, obtained from the juice of plants such as the *Anacardiaceæ*, which are pale and transparent when fresh drawn, but gradually darken in colour on exposure to air. Bertrand found in these juices an oxydase, which he terms *laccase*, and which affects the oxygen-carrying, and converts the pale fluid juice to a hard dark brown varnish.

Other oxydases have been isolated from beets, *dahlia*, potato-tubers, and several other plants.

These discoveries led Bourquelot and Bertrand in 1895 to the explanation of a phenomenon long known to botanists, and partly explained by Schönbein as far back as 1868. If certain Fungi (e.g. *Boletus luridus*) are broken or bruised, the yellow or white flesh at once turns blue: the action is now traced to the presence in the cell-sap of an oxydase, the existence of which had been suspected but not proved, and the observers named assert that many fungi (59 out of 107 species examined) contain such oxydases.

It will be interesting to see how far future investigations support or refute the suggestion that many of the colour-changes in diseased tissues of plants attacked by fungi are due to the action of such oxydases.

Wortmann, in 1882, showed that bacteria, which are capable of secreting diastase, can be made to desist from secreting this enzyme if a sufficient supply of sugar be given them, and since then several instances have been discovered where fungi and bacteria show changes in their enzyme actions according to the nature of their food supply. Nor is this confined to fungi. Brown and Morris, in 1892, gave evidence for the same in the seedlings of grasses: as the sugar increased, the production of diastase diminished.

It is the diastatic activity of *Aspergillus* which is utilised in the making of saké from rice in Japan, and in the preparation of soy from the soja-bean in the same country, and a patented process for obtaining diastase by this means exists; and Katz has recently tested the diastatic activity of this fungus, of *Penicillium*, and of *Bacterium magatherium* in the presence of large and small quantities of sugar. All three organisms are able to produce not only diastase, but also other enzymes, and the author named has shown that as the sugar accumulates the diastase formed diminishes, whereas the accumulation of other carbo-hydrates produces no such effect.

Hartig's beautiful work on the destruction of timber by fungi obtains new interest from Bourquelot's discovery of an emulsion-like enzyme in many such wood-destroying forms. This enzyme splits the Glucosides, Amygdalin, Salicin, Coniferin, &c., into sugars and other bodies, and the hyphæ feed on the carbo-hydrates. I purpose to recur to this subject in a communication to this Section. The fact that *Aspergillus* can form invertins of the sucrase, maltase, and trehalase types, as well as emulsin, inulase, diastase, or trypsin, according to circumstances of nutrition, will explain why this fungus can grow on almost any organic substratum it alights on, and other examples of the same kind are now coming to hand.

The secretion of special enzymes by fungi has a peculiar interest just now, for recent investigations promise to bring us much nearer to an understanding of the phenomena of parasitism than we could hope to attain a few years ago.

De Bary long ago pointed out that when the infecting germinal tube of a fungus enters a plant-cell, two phenomena must be taken into account, the penetration of the cell-walls and tissues, and the attraction which causes the tips of the growing hypha to face and penetrate these obstacles, instead of gliding over them in the lines of apparent least resistance.

The further development of these two themes has been steady and unobtrusive, and from various quite unexpected directions more light has been obtained, so that we are now in a position to see pretty clearly what are the principal factors involved in the successful attack of a parasitic plant on its victim or "host." That fungi can excrete cellulose-dissolving enzymes is now well known, and that they can produce enzymes which destroy lignin must be inferred from the solution of wood-cells and other lignified elements by tree-destroying fungi. Zopf has collected several examples of fungi which consume fats, and further cases are cited by Schmidt, by Ritthausen, and Baumann. In these cases also there can be no doubt that an enzyme or similar body is concerned.

There is one connection in which recent observations on enzymes in the plant-cell promise to be of importance in explaining the remarkable destructive action of certain rays of the solar-light on bacteria. As you are aware, the English observers Downes and Blunt showed long ago that if bacteria in a nutrient liquid are exposed to sunlight, they are rapidly killed. Further researches, in which I have had some part, gradually brought out the facts that it is really the light rays and not high temperatures which exert this bactericidal action, and by means of a powerful spectrum and apparatus furnished by the kindness of Prof. Oliver Lodge I was able to obtain conclusive proof that it is especially the blue-violet and ultra-violet rays which are most effective. This proof depended on the production of actual photographs in bacteria of the spectrum itself. Apart from this, I had also demonstrated that just such spores as those of anthrax, at the same time pathogenic and highly resistent to heat, succumb readily to the action of these cold light-rays, and that under conditions which preclude their being poisoned by a liquid bathing them.

The work of Brown and Morris on the daily variations of diastatic enzyme in living leaves, and especially Green's recent work on the destructive action of light on this enzyme, point to the probability that it is the destruction of the enzymes with which the bacterial cells abound which brings about the death of the cell.

That these matters are of importance in limiting the life o. bacteria in our streets and rivers, and that the sun is our most powerful scavenger, has been shown by others as well as myself. In this connection may also be mentioned Martinand's observations, that the yeasts necessary for wine-making are deficient in numbers and power on grapes exposed to intense light, and he explains the better results in Central France as contrasted with those in the South as largely due to this fact. Whether, or how far, the curious effects of too intense illumination in high latitudes and altitudes on plants which might be expected to grow normally there, can be explained by a destructive light action on the enzyme of the leaves, has not, so far as I know, been tested; but Green's experiments certainly seem to me to point to the possibility of this, as do the previous experiments with screens of Pick, Johow, myself, and others.

It is interesting to note that Wittlin and others have confirmed the conclusion my own few trials with Röntgen rays led to; they show no action whatever.

That branch of mycology which is now looked upon by so many as a separate department of science, usually termed bacteriology, only took shape in the years 1875-79, when its founder, the veteran botanist Cohn, who recognised that the protoplasm of plants corresponded to the animal sarcode, and who has been recently honoured by our Royal Society, published his exact studies of these minute organisms, and prepared the way for the specialists who followed.

It is quite true that isolated studies and observations on bacteria had been made from time to time by earlier workers than Cohn, though it is usually overlooked that Cohn's first paper on Bacteria was published in 1853. Ehrenberg in

particular had paid special attention to some forms; but neither he nor his successors can be regarded as having founded a school as Cohn did, and this botanist may fitly be looked upon as the father of bacteriology, the branch of mycology which has since obtained so much diversity.

It should not be overlooked that the first proof that a specific disease of the higher animals is due to a bacillus, contained in Koch's paper on Anthrax, was published under Cohn's auspices and in his "Beiträge zur Biologie der Pflanzen" in 1876, four years after Schroeter's work from the same laboratory on pigmented bacteria, and that the plate illustrating Koch's paper was in part drawn by Cohn.

It is of primary importance to recognise this detail of Koch's training under Cohn, because, as I have shown at length elsewhere, popular misapprehensions as to what bacteriology really consists in have been due to the gradual specialisation into three or four different schools or camps of a study which is primarily a branch of botany; and, again, it is of importance to observe that the whole of this particular branch of mycology, to which special laboratories and an enormous literature are now devoted, has arisen during the last quarter of a century, and subsequent to the foundation of scientific mycology by De Bary. When we reflect that the nature of parasitic fungi, the actual demonstration of infection by a fungus spore, the transmission of germs by water and air, the meaning and significance of polymorphism, heterœcism, symbiosis, had already been rendered clear in the case of fungi, and that it was by these and studies in fermentation and in the life-history of the fungus *Saccharomyces* that the way was prepared for the ætiology of bacterial diseases in animals, there should be no doubt as to the mutual bearings of these matters.

Curiously enough, it was an accident which deflected bacteriology along lines which have proved so significant for the study of this particular group of minute organisms, that an uninitiated visitor to a modern bacteriological laboratory (which in England, at any rate, is usually attached to the pathological department of a medical school) hardly perceives that he is in a place where the culture of microscopic plants is the chief object—for the primary occupation of a bacteriologist is really, after all, the cultivation of minute organisms by the method of "microscopic gardening," invented by De Bary, Klebs, and Brefeld, whether the medium of culture is a nutritive solution, or solid organic substrata like potato, agar, or gelatine, or the tissues of an animal.

This accident—I use the word in no disrespectful sense—was Koch's ingenious modification of the use of gelatine as a medium in which to grow bacteria: he hit upon the method of pouring melted gelatine containing distributed germs on to plates, and thus isolating the colonies.

Pasteur and Cohn had already coped with the difficulty of isolating mixed forms by growing them in special fluids. When a given fluid favoured one form particularly, a small quantity containing this predominant species was put into another flask of the fluid, then a drop from this flask transferred to a third flask, and so on, until the last flasks contained only the successful species, the others having been suppressed: these "fractional cultures" were brought to a high state of perfection by the botanist Klebs in 1873.

Then Brefeld (1872) introduced the method of dilution—*i.e.* he diluted the liquid containing his spores until each single drop taken contained on the average one spore or none, whence each flask of sterile nutritive solution receiving one drop contained either none or *one* spore. Brefeld was working with fungi, but Lister—now Lord Lister, and our late President—applied this "dilution method" to his studies of the lactic fermentation in 1878, and Naegeli, Miquel, and Duclaux carried it further, the two latter especially having been its chief defenders, and Miquel having employed it up to quite recently.

Solid media appear to have been first generally used by Schroeter in 1870, when he employed potatoes, cooked and raw, egg-albumen, starch-paste, flesh, &c. Gelatine, which seems to have been first employed by Vittadini in 1852, was certainly used by Brefeld as early as 1874, and even to-day his admirable lecture on "Methoden zur Untersuchung der Pilze" of that date is well worth reading, if only to see how cleverly he obtains a single spore isolated in gelatine under the microscope. Klebs used gelatine methods in 1873.

We thus see that when Koch proposed his method of preparing gelatine plate-cultures in 1881 he instituted, not a new culture-medium, for cultures on solid media, including gelatine, had been in use by botanists for eight or ten years; nor did he introduce methods for the isolation of spores, for this had been done long before. What he really did was to ensure the isolation of the spores and colonies wholesale, and so facilitate the preparation of pure cultures on a large scale, and with great saving of time.

It was a brilliant idea, and, as has been said, "the Columbus egg of Bacteriology"; but we must not lose sight of the fact that it turned the current of investigation of bacteria from the solid and trustworthy ground established by Cohn, Brefeld, and De Bary, into a totally new channel, as yet untried.

We must remember that De Bary and Brefeld had aimed at obtaining a single spore, isolated under the microscope, and tracing its behaviour from germination, continuously to the production of spores again; and when we learn how serious were the errors into which the earlier investigators of the mould-fungi and yeasts fell, owing to their failure to trace the development continuously from spore to spore, and the triumphs obtained afterwards by the methods of pure cultures, it is not difficult to see how inconclusive and dangerous all inferences as to the morphology of such minute organisms as bacteria must be unless the plant has been so observed.

As matter of fact, the introduction and gradual specialisation of Koch's methods of rapid isolation of colonies encouraged the very dangers they were primarily intended to avoid. It was soon discovered that pure cultures could be obtained so readily that the characteristic differences of the colonies in the mass could presumably be made use of for diagnostic purposes, and a school of bacteriologists arose who no longer thought it necessary to patiently follow the behaviour of the single spore or bacillus under the microscope, but regarded it as sufficient to describe the form, colour, markings, and physiological changes of the bacterial colonies themselves on and in different media, and were content to remove specimens occasionally, dry and stain them, and describe their forms and sizes as they appeared under these conditions.

To the botanist, and from the points of view of scientific morphology, this mode of procedure may be compared to what would happen if we were to frame our notions of species of oak or beech according to their behaviour in pure forests, or of a grass or clover according to the appearance of the fields and prairies composed more or less entirely of it, or—and this is a more apt comparison, because we can obtain colonies as pure as those of the bacteriologist—of a mould-fungus according to the shape, size, and colour, &c., of the patches which grow on bread, jam, gelatine, and so forth.

Now it is obvious that this is abandoning the methods of morphology, and the consequence has been that two schools of descriptive bacteriologists are working along different lines, and the "species" of the one—the test-tube school—cannot be compared with those of the other, the advocates of continuous culture from the spore.

The difficulty of isolating a bacterium and tracing its whole life-history under the microscope is so great, that the happy pioneers into the fascinating region opened up by the test-tube methods may certainly claim considerable sympathy in their cry that they cannot wait. Of course they cannot wait; no amount of argument will prevent the continual description of new test-tube "species," and all we can do is to go on building up the edifice already founded by the botanists Cohn, Brefeld, De Bary, Van Tieghem, Zopf, Prazmowski, Beyerinck, Fischer, and others who have made special studies of bacteria.

The objection that such work is slow and difficult has no more weight here than in any other department of science, and in any case the test-tube school is already in the plight of being frequently unable to recognise its own "species," as I have convinced myself by a long-continued series of cultures with the object of naming common bacteria.

I wish to guard myself against misconstruction in one particular here. It is not insinuated that the test-tube methods and results are of no value. Far from it; a vast amount of preliminary information is obtained by it; but I would insist upon the discouragement of all attempts to make "species" without microscopic culture; and continuous observation of the development as far as it can be traced.

The close connection between bacteriology and medicine has been mainly responsible for the present condition of affairs; but it is high time we recognised that bacteriology only touches animal pathology at a few points, and that the public learn that, so far from bacteria being synonymous with disease germs, the

majority of these organisms appear to be beneficial rather than inimical to man. There is not time to attempt even a brief description of all the "useful fermentations" due to bacteria, but the following cases will point the conviction that a school of bacteriology, which has nothing to do with medical questions, but investigates problems raised by the forester, agriculturist, and gardener, the dairyman, brewer, dyer, and tanner, &c., will yet be established in England in connection with one or other of our great botanical centres.

(*To be continued.*)

PHYSICS AT THE BRITISH ASSOCIATION.

THE meeting of the American Association at Detroit and the central position of Toronto have contributed greatly in bringing together a large number of Canadian and American mathematicians and physicists to meet their co-workers on this side of the Atlantic. The opportunity thus afforded of conference and exchange of ideas has been one of the chief pleasures of the meeting.

It was universally felt that the presidential address of Prof. Forsyth (pp. 374–378) formed a clear and eloquent exposition of the claims of pure mathematics, and at its close Lord Kelvin, in moving a vote of thanks, declared that any one in science who could possibly choose would elect to belong to the mathematical rather than the non-mathematical class. President London, of the Toronto University, in seconding the vote, said that the address was specially needed in Toronto, because the public there had accused the university of attaching too much importance to mathematics.

Mr. J. A. Paterson, in a paper on the unification of time, described the efforts made by several scientific societies in Canada to secure uniformity in the specification of time by astronomers, navigators and the public; the suggestion being that the day should commence and end at midnight, and the hours be counted from 0 to 24. The proposal gave rise to some discussion. Prof. Newcomb pointed out that navigators, making observations usually at noon, found that time most convenient as the commencement of the day, while astronomers for similar reasons would choose midnight. Prof. Rücker gave an account of the inquiries made by the British Royal Society, Foreign Office and Admiralty, from which it appears that any international agreement is at present hopeless; so that the Nautical Almanac for 1901 will be compiled in the same manner as its predecessors.

Prof. Rücker exhibited photographic records of objective combination tones, both summational and difference tones having been obtained. In this research he was assisted by Messrs. Forsyth and Sowter. The method and apparatus used were the same as in the investigation of Prof. Rücker and Mr. Edser—namely, the observation of interference bands produced by the light reflected from a mirror carried by a resonant tuning-fork; the shift of the bands by the motion of the fork was, however, photographed on a moving sensitive surface, instead of being observed by eye.

An account of the work of the Committee on Seismological Observations was given by its indefatigable secretary, Prof. Milne. An examination of earthquake records seems to show that sub-oceanic earthquakes and landslips are more frequent than those on land, and that the Tuscarora deep is the origin of many of them. The most important portion of the report is, however, that relating to the rate of propagation of seismic waves from their origin to various points on the earth's surface. The records show that the velocity of propagation increases with the distance travelled, so that most probably the wave goes through the earth and not round its superficial crust, the speed of transmission being greater in the interior than in the crust. This, as Lord Kelvin pointed out, indicates that the moduli of elasticity of the material of the earth's interior are greater than those of the crust, possibly because of the higher pressure at great depths.

At the meeting of the section on Friday, Dr. N. E. Dorsey described some careful experiments to determine the surface tension of water by the method of ripples, the results of which agree with those of M. Sentis, obtained by an entirely different method. In the case of dilute aqueous solutions, the surface tension obtained by this method is a linear function of the concentration.

Prof. Callendar and Mr. Barnes gave an account of their new method of measuring the specific heat of liquid, by passing an electric current through a fine tube through which a current of the liquid flows. The experiment is continued until the temperature-difference between the ends of the tube becomes steady; this temperature-difference and the rate of flow of the liquid are then measured. Loss of heat by radiation is almost eliminated by surrounding the tube with a vacuous chamber, and small losses are allowed for. Another important communication on calorimetry was that of Profs. Ewing and Dunkerley on the specific heat of superheated steam. Their method consists in passing saturated steam through a porous plug, thus superheating it; the results show that for 10° superheating at atmospheric pressure the specific heat is about 0·44, while the ordinarily accepted value, 0·48, is only correct if the superheating exceeds 25°, as in Regnault's experiments.

A crowded audience assembled to hear Lord Kelvin's paper on the fuel-supply and air-supply of the world. He argued that, as the earth was in all probability originally hot and liquid, no primeval vegetable fuel existed; further, no free oxygen existed at that period, since it is not found in gases evolved from minerals or in the spectra of stars. Probably, therefore, the oxygen of the air has resulted from the action of sunlight on plants, and as this oxygen would be furnished by 340 million million tons of fuel, we have an upper limit to the amount of fuel in the world. On the other hand, the British Coal Supply Commission of 1831 estimated the amount of available fuel in England and Scotland to be 146,000 million tons, which is greater than the average for the whole earth. It follows, then, that the oxygen of the atmosphere resting over Britain is insufficient to burn up the fuel of the country, and the cessation of life may possibly occur by asphyxiation rather than want of fuel. In the discussion on this paper Prof. Fitzgerald stated that, according to his calculations, the sun's energy will support five persons to every square metre, so that there is no fear of life becoming extinct by failure of the sun's energy, as some people have supposed.

In spectroscopy, Prof. Runge stated that Prof. F. Paschen and himself had succeeded in separating the spectrum of oxygen into six series, two principals each having two subordinates, the lines of one principal series and its subordinates being triple. The importance of this paper lies in the fact that the oxygen spectrum is shown to be analogous to that of helium; and as oxygen does not, so far as we know, contain a mixture of elements, the idea that helium is a mixture has now been abandoned. Profs. Runge and Paschen find also that the spectra of sulphur and selenium each give a principal series of lines and two subordinate series, but in each case one line occurs which does not fit into any of the series, and which may be the fundamental line of another series. Using the large grating of the Johns Hopkins University, Mr. W. J. Humphreys has succeeded in causing the lines in the arc spectra of metals to shift appreciably by increasing the pressure of the atmosphere surrounding the arc; in all cases increased pressure causes the wave-length of the lines to increase, the lines move towards the red end of the spectrum. The shift is of the same order of magnitude as the Doppler effect, but could be distinguished from the Doppler effect in a celestial spectrum by the fact that lines belonging to principal and subordinate series are differently shifted by pressure, whereas they are all displaced equally in the spectrum of a receding body. Dr. J. Larmor has discussed the subject mathematically, and finds that the displacement is of the same order as would be produced by change of specific inductive capacity of the air by pressure. Prof. Schuster has photographed a metallic spark-spectrum on a film moving rapidly at right angles to the slit of the spectroscope; the result shows that the air-lines flash out for an exceedingly short time: the metallic particles, however, remain luminescent for a much longer period with gradually diminishing intensity. He was able to trace the motion of the metallic particles from the electrodes to the middle of the spark, and to measure their velocity, which ranged from 400 to 2000 metres per second.

Prof. S. P. Thompson distinguished four varieties of kathode rays, differing in their power of exciting fluorescence, exciting X-rays, and deflexion by a magnet. The first kind is the ordinary kathode ray; the second kind is produced when kathode rays have fallen on a surface and produced X-rays (they have then lost their power of exciting more X-rays). The third variety arises when kathode rays are passed through a negatively charged metallic spiral or gauze-sieve; they cannot be deflected

by a magnet. The fourth kind appears at the openings in a Holtz's funnel-tube; it produces no fluorescence, but can be deflected by a magnet.

A serious state of things was revealed by Prof. A. Johnson in his paper on a Canadian and Imperial Hydrographic Survey. He said that in some parts of the St. Lawrence basin places had been found where the depth of water, charted at five fathoms, was not more than three fathoms, and navigation was thereby rendered dangerous. A committee has been appointed to consider the question of approaching the Canadian Government with reference to a new hydrographic survey.

On Monday the section met in two departments, devoted to mathematics and meteorology respectively. In the mathematical department Dr. Harris Hancock gave a short account of the historical development of Abelian Functions, and the complete paper will be published as one of the reports of the Association. Prof. Henrici proposed a new notation to denote the different products of vectors, which consists in using square brackets for vector products and round brackets for scalar products. He likewise advocated the adoption of Heaviside's term "ort" for a vector, the tensor of which is the number 1. Prof. A. Macfarlane read a communication on the solution of the cubic equation, in which he explained how the two binomials in Cardan's formula may be treated as complex quantities, either circular or hyperbolic; all the roots of the cubic can then be deduced by a general method. Prof. Michelson described some new Harmonic Analyses made by himself and Mr. S. W. Stratton with an instrument which is capable of rendering 80 terms of a Fourier series and of checking the accuracy of its own work. The only limit to the number of terms obtainable is the expense of making the instrument.

In the department of meteorology, Dr. van Rijckevorsel pointed out that the curves of daily temperature for the different meteorological stations in Europe indicate a possible division of the continent into two regions with marked differences of climate. The eastern region includes Russia and adjacent countries, the rest of the continent being in the western region. Small irregularities, such as secondary maxima and minima, are reproduced in all the curves for places in the same region, and serve to show that the temperatures are determined by external causes operating over the whole area. Mr. F. N. Denison described observations on "seiche" movements on Lakes Ontario and Huron, obtained by means of a tidal gauge. Mr. A. L. Rotch reported progress made during the year in the exploration of the air by means of kites. Meteorographs have been raised to a height of 8740 feet above the Blue Hill Observatory, and important information has been obtained concerning humidity, changes of temperature and wind in free air. The value of these results in aiding the forecasting of the weather is so great that the United States Weather Bureau has taken up the subject. Prof. Marvin described his experiments with tailless kites, and afterwards exhibited one in flight in the University grounds.

In electricity, several forms of apparatus for mapping out the form of an alternate current wave were described and exhibited. In the instrument of Prof. Rosa a contact revolving on the dynamo shaft puts a point in the circuit into contact with a potentiometer at any phase of the revolution. By means of an electro-magnetic ratchet arrangement the contact can be advanced in phase by small equal amounts, and the same current similarly rotates a revolving cylinder on which the length of wire necessary for a balance on the potentiometer is automatically recorded. Mr. Duddell makes use of the force urging a straight conductor carrying a current and stretched in a magnetic field; two parallel phosphor-bronze strips are placed in a strong magnetic field and attached to a mirror, so that when the alternating current goes up one of these strips and down the other one, the mirror is deflected. Prof. Braun uses a kathode ray instead of a strip, and puts it in a magnetic field set up by the alternating current; the ray is thus deflected and follows every pulsation of the current. The source of luminosity in the electric arc has been investigated by Prof. Henry Crew and Mr. O. H. Basquin. They maintain an arc between an iron rod and a rotating iron disc by a rapidly intermittent electric current, and observe the arc in the intervals when no current is passing. It is found that the luminosity is of two kinds, a bright cloud yellow persisting some time and a much fainter and rapidly evanescent blue flame; the spectra of these two portions differ in the distribution of intensity of their lines.

The Electrical Standards Committee report that they have decided to undertake the experiments necessary for the specification of the standard of electric current, which will be conducted by Profs. Ayrton and J. V. Jones.

At Wednesday's sitting, Prof. Ramsay described experiments on the refractivity of mixtures of gases, from which it appears that an expansion takes place on mixing hydrogen and helium, and a contraction on mixing nitrogen and oxygen. Prof. Fitzgerald suggested that the viscosity of mixtures of gases should be more fully examined. Prof. Lodge described Zeeman's discovery of the effects of magnetism on spectral lines, and discussed the nature of the dark space between the two lines into which the originally single band is split. Profs. Lodge, Michelson and Runge were agreed that this space is a part of the Zeeman phenomenon, and is not produced merely by the absorption of light in the region round the flame. Several papers on galvanometry were communicated by Prof. Ayrton and Mr. Mather. In the discussion on papers by Prof. Callendar and Mr. Barnes, and Messrs. Spiers, Twyman and Waters, on Clark cells, it was stated by Prof. Webster, that Clark cells with cadmium electrodes in place of zinc are as trustworthy and easily set up as the older form. Such cells have a much smaller temperature coefficient than zinc-cells.

The meeting concluded with a paper by Mr. J. W. Edmondson, read by Prof. Webster, on spark-length and potential relations in air and dielectric liquids. For air a hyperbolic formula apparently fits the results in the case of spheres of 3 cm. diameter.

A vote of thanks to the President, moved by Prof. Ayrton and seconded by Prof. Lodge, brought the proceedings of the section to a close.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meetings of the Chemistry Section were usually well attended throughout the whole of the somewhat protracted sittings at Toronto. A large number of the chemists of Canada and of the United States were present, and added much to the interest of the meeting, both within and without the section room. The section only participated, and that in an informal way, in one united discussion, which took place between Sections I and K on the chemistry and structure of the cell. This was opened by Prof. Meldola in a very striking and suggestive paper on the rationale of chemical synthesis.

In connection with the section an important new committee has been appointed, under the chairmanship of Sir John Evans, for the promotion of agriculture, its object being to report on the methods and results of the Government Agricultural Stations in Canada and other countries, with a view to the establishment of similar institutions in Great Britain. As an unusually large number of papers were read, only those of the most general interest can be here mentioned.

Prof. Ramsay followed up his address, which was none the less interesting because of its speculative character, by an account of the methods employed in the work on helium and in the determination of the remarkable properties by which that gas is characterised. He expressed the opinion that helium is occluded, and not definitely combined in the various minerals in which it occurs. A short communication was also read, in which it was pointed out by Mr. M. Travers that the hydrogen obtained by heating many igneous rocks *in vacuo* is in reality derived from water which is present, and is reduced by various substances, such as ferrous oxide, contained in the material of the rock.

The section devoted a considerable portion of one of its sittings to the consideration of atomic weights, and was fortunate in the attendance of Profs. B. Brauner, F. W. Clarke, E. W. Morley and T. W. Richards, in addition to the home contingent of chemists distinguished in this particular field. Prof. Brauner, resting from his labours on tellurium, has turned his attention to thorium, and has succeded in making a satisfactory determination of its atomic weight by the oxidation of the double ammonium oxalate. The number which he has obtained is 232·5 ($O=16$), and is considerably lower than Cleve's number. Prof. Richards has attacked the problem of the atomic weights of nickel and cobalt, about which great uncertainty has hitherto prevailed, and has analysed the very carefully dried and purified bromides of these metals. The separate determinations agree admirably among themselves, and it seems probable that the

values Ni = 58·69, and Co = 58·99 will take their places as standards among the numerous other results, which have been obtained in such rapid succession in the laboratory of Harvard.

One of the most attractive items on the programme of the section was the demonstration of the preparation and properties of fluorine, by Prof. E. Meslans. Since the Nottingham meeting, at which the demonstration was made for the first time in England, an important simplification has been introduced into the apparatus required for the production of the gas, which will probably render it possible to include the preparation of this element in the ordinary course of lecture experiments, and may even lead to its economical production on the large scale, should any industrial application of the gas be found desirable. The latest form of apparatus consists entirely of copper, and is larger than the costly platinum apparatus of Moissan, although the same general shape is preserved. The apparatus is charged in the usual way, and is then itself connected with the positive terminal of a battery, the two eleectrodes being made the negative pole. Fluorine is thus evolved at the internal surface of the apparatus, and a thin non-conducting layer of copper fluoride is deposited upon it. The apparatus after this preliminary treatment is employed exactly in the same way as Moissan's platinum apparatus, but may be simply cooled by ice and salt. The presence of the non-conducting layer of copper fluoride prevents the passage of electricity from the electrode to the side of the vessel, and thus avoids the consequent loss of fluorine; so that the yield in the new modification of the apparatus is much greater than in the original form.

Several papers on subjects connected with physical chemistry were contributed. The first of these was read by Prof. H. B. Dixon, in continuation of his previous work on explosions of gases, and dealt with the curious phenomena attending the commencement of an explosion in a gaseous medium, which may be investigated by photographing the flash. If the mixture be fired at the end of a tube, the disturbance very gradually increases in velocity as it passes along the tube, until after a comparatively great distance has been traversed, the velocity characteristic of the mixture is reached. When, however, the firing-point is 3 or 4 inches from the end of the tube, the disturbance passing slowly down the longer portion of the tube is reinforced by the wave which has traversed the short distance to the end of the tube, and has there been reflected. After this reinforcement, the united disturbances travel at a much more rapid rate, and the maximum velocity is quickly attained. Another investigation on the mechanism of a reaction, but from a different point of view, was described by Dr. J. W. Walker in a paper dealing with the reaction between hydrobromic and bromic acids in aqueous solutions. Time measurements of the rate of liberation of bromine show that most probably the reaction does not take place between six molecules as indicated in the ordinary equation, but between two. It is therefore probable that the reduction of the bromic acid takes place in stages, bromous and hypobromous acids being probably formed as intermediate products. Dr. W. L. Miller, of Toronto University, in a paper on the vapour tensions of mixed liquids, explained the method adopted by himself and Mr. Rosebrough for testing the validity of Gibb's equation for the equilibrium of the vapours of mixtures of liquids at constant temperatures, and demonstrated that actual determinations of the composition of the vapour given off from various mixtures of alcohol and water agree very closely with the calculated numbers. The Röntgen rays again formed the subject of an investigation at the hands of Dr. J. H. Gladstone and Mr. W. Hibbert, who have compared the absorptive power of various salts of the same metal (lithium), and have thus obtained relative values for the various acid radicals.

A number of short papers on organic chemistry were communicated to the section, including a review by Prof. P. C. Fuer, of his work on the constitution of acetone and other analogous ketones; the formation of a benzene ring by the reduction of a 1-6-di-ketone, by Dr. A. Lehmann; condensation products of aldehydes and amides, by Dr. C. A. Kohn; and on the nitro-alcohols, by Prof. L. Hemy, of Louvain. Great interest was excited by a very able paper on the chemistry of methylene, by Prof. J. V. Nef, of Chicago, in which the latest results obtained in the study of compounds containing dyadcarbon were described. Prof. Nef has obtained a very unstable series of substances which he regards as acetylidene derivatives, $CR_2 = C$, isomeric with the normal acetylene derivatives $RC \equiv CR$. The di-iodo-compound is the most stable, but even this slowly burns when exposed to the air, whilst the other derivatives undergo a much more rapid combustion under the same circumstances. All the compounds are violently poisonous. The di-iodo-derivative can be prepared in a number of different ways, the most interesting of which are (1) the direct action of sunlight on tetra-iodoethylene, $I_2C = CI_2$, one molecule of iodine being liberated; and (2) the action of iodine on silver acetylene. On oxidation it appears to primarily yield carbonic oxide and iodine, but the latter converts a portion of the unaltered compound into tetraiodo-ethylene. The monobromo-derivative bears in its properties a most remarkable resemblance to phosphorus, and is termed by its discoverer "vegetable phosphorus," since it shines in the dark, burns on exposure to the air, and acts as a violent poison, in the same way as phosphorus.

Several papers dealing with local problems were presented by various chemists. The most elaborate of these was a very extensive series of analyses of the virgin soils of Canada, submitted by Dr. F. T. Shutt, who occupies the important position of chemist to the Dominion Experimental Farm at Ottawa. These showed that some of the prairie soils of Manitoba are of extraordinary richness and fertility, whilst the soils of Canada in general may be considered as of a satisfactory character for agricultural purposes. Some interesting analyses of coal from the pre-carboniferous rocks of Canada were communicated by Prof. Ellis, of Toronto. These showed in a very striking way the gradual transition from petroleum and its immediate product of decomposition, asphalt, to anthracite and pure carbon. Prof. Roberts-Austen showed a number of interesting slides, which supplemented the information given in his evening lecture on the metals of Canada, as to the close similarity of the phenomena exhibited by ordinary liquids, and metals in the molten, and even in the solid form. Mr. Ramage also exhibited a series of slides, reproduced from photographs of the spectra of various metals and minerals in the oxyhydrogen flame, showing the presence of many unsuspected constituents in very small amounts.

Great interest was shown in a demonstration by Prof. Andrews, of the plaster of Paris method in blowpipe work. In this method charcoal is replaced by a thin, oblong tablet made of plaster of Paris, mixed with a little boric acid. This can be employed for all the ordinary tests which are conducted on charcoal or platinum wire. Prof. Andrews has, moreover, elaborated a series of extremely delicate and characteristic tests for a large number of metals, which depend on the coloured films produced when compounds of these metals are treated with a solution of iodine in potassium thiocyanate. These consist partly of oxide and sulphide, partly of iodide and oxyiodide, and are very brilliant in colour. Although not so suitable for teaching purposes, these iodide films afford a very ready method for the detection of the constituents of a metal in the field, and will no doubt be welcomed by practical mineralogists.

An interesting, though somewhat speculative, attempt was made by Mr. L. T. Addison to refer the different crystalline forms and specific gravities of the allotropic forms of many of the elements to different modes of arrangement of the same primal forms, the shape of which is intimately connected with the valency of the element.

A break in the routine of business was enjoyed by the members of the section on Saturday, when a visit was paid to the electric power-house at Niagara, and the works for the production of carborundum and of soda by the electrolytic process, which are in its immediate neighbourhood, and derive their energy from the diverted waters of the Fall.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. JULIUS HANN, Director of the Vienna College of Meteorology, has been appointed professor of meteorology at Gratz, in Styria. Prof. Joseph Pernter, professor of cosmical physics in Innsbruck University, has been appointed to the vacancy caused by Dr. Hann's retirement from the Vienna College. Dr. E. von Esmarch, assistant professor of hygiene at Königsberg, has been made full professor. Mr. William Saunders, second master at the Cardigan Intermediate School, has been appointed head master of the Radnorshire County School at Llandrindod Wells.

IN an address delivered before the British Medical Association at the meeting in Montreal last week, Dr. T. G. Roddick, the President of the Association, gave a description of the condition of medical education in Canada. He showed that laboratory methods prevail in the medical schools of the Dominion, all with the idea of developing the scientific spirit in students, and of cultivating methods of thought with observation. Referring to the value of a preliminary science course, he said that the late Prof. Huxley thought it was a most self-evident proposition that the educational training for persons who proposed to enter the medical profession should be largely scientific; not merely or even principally because an acquaintance with the elements of physical and biological science is absolutely essential to the comprehension of human physiology and pathology, but still more because of the value of the discipline afforded by practical work in these departments in the process of observation and experiment, in inductive reasoning, and in manipulation.

EDUCATION in science is not obtained by reading, but by personal observation and experience. It is possible, however, to create and stimulate an interest in natural knowledge by means of books wisely selected and used. This is what the National Home Reading Union aims at doing. The work of the Union is mainly concerned with literature and human history, but it also includes natural history. During the session 1897-98, shortly to commence, a course of reading in elementary botany will be taken. The session is not a favourable time for the study of flowering plants, but flowerless plants can be studied as well in the winter as in the summer. Among the latter plants especial weight will be given in the course to those forms of fungi and algæ which have been recently shown to play so large a *rôle* in the preparation of soil, in the ripening of cheese, and in other industrial processes, as well as in the causation of disease in plants and animals. The course will thus not only draw attention to interesting forms of plant life, but will also be of assistance in understanding the nature of bacteria. We presume that the students who take up the course are recommended to obtain a small microscope, and are instructed how to use it in the observation of the organisms described.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 30.—M. A. Chatin in the chair.—On the hypocycloid of Steiner, by M. Paul Serret.—On plasmolysis, by M. Mouton.—Photography of fluoroscopic images, by M. Charles Porcher.—*Pseudocommis vitis* (Debray), a parasite of marine plants, by M. E. Roze.

NEW SOUTH WALES.

Linnean Society, July 28.—Prof. J. T. Wilson, President, n the chair.—On the occurrence of the genus *Palæchinus* in the Upper Silurian rocks of New South Wales, by John Mitchell. The author described and figured a fragmentary specimen comprising the middle portion of an interambulacral area showing four rows of plates, from the Middle Trilobite Bed, Bowning Village, N.S.W.—Two ornate boomerangs from North Queensland, by R. Etheridge, junr.—New Australian lepidoptera, by Oswald B. Lower. Eighteen species, chiefly referable to the *Œcophoridæ* and *Gelechiadæ*, are described as new.—On the Cinnamomums of New South Wales: with a special research on the oil of *C. Oliveri*, Bailey, by R. T. Baker. The genus *Cinnamomum*, hitherto unrecorded for New South Wales, is now shown to occur over a large area of the coastal district, being represented by two species, *C. Oliveri*, Bailey, and *C. virens*, sp. nov. The former species has in the past been mistaken in the northern colony for *Beilshmiedia obtusifolia*, and has only recently been identified as a *Cinnamomum*; very probably the same confusion of species has occurred in New South Wales. *C. virens* appears to stand somewhat alone, its affinities with known species not being very marked. Descriptions of the timber, gall-fungus, bark and oil are given. The oil obtained from *C. Oliveri* is highly aromatic, and is found to contain cinnamic aldehyde, eugenol, together with other constituents. The bark gave nearly 1 per cent. of oil. It is hoped that a new commercial product may result from these investigations.—On the Rhopalocera of Lord Howe Island, by G. A. Waterhouse. The late Mr. A. S. Olliff enumerated ten species as occurring on the island [" Lord Howe Island," &c. Memoirs of Australian Museum. No. ii. p. 98, 1889]. The number is now increased to eighteen species, of which eight were not previously recorded. All the species are known to occur on the Australian continent. —Stray notes on Papuan ethnology, part ii., by C. Hedley. Two articles from New Guinea are described: (*a*) A gigantic fish hook, 19 inches long, usually miscalled a shark hook, brought from Milne Bay by Mr. N. Hardy. Recent researches in the Ellice Islands indicate that this is employed to catch a deep-sea fish there called "Palu"; possibly an unknown species of the *Macruridæ*. The present hook differs from any hitherto known by a mounting of wicker work for the attachment of the fishing line. (*b*) An intricate knot used by the women of East New Guinea in making the grass petticoat; and attention is drawn to the value of such a detail in tracing the migration or descent of races.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The New Psychology: Dr. E. W. Scripture (Scott).—Leghe Metalliche ed Amalgame: I. Ghersi (Milano, Hoepli).—La Fabricazioni dell' Acido Solforico: Dr. V. Vender (Milano, Hoepli).—Manuale del Chimico e dell' Industriale: Prof. L. Gabba (Milano, Hoepli).—Philosophy of Knowledge: Prof. G. T. Ladd (Longmans).—Laboratory Practice for Beginners in Botany: Prof. W. A. Setchell (Macmillan).—Natural Elementary Geography: J. W. Redway (New York, American Book Company).—Chart of the World: Dr. H. Berghaus, xii. edition (Gotha, Perthes).

PAMPHLETS.—A Critical Period in the Development of the Horse: Prof. J. C. Ewart (Black).—Archeological Studies among the Ancient Cities of Mexico: W. H. Holmes, Part 2 (Chicago).—Observations on Popocatepetl and Ixtaccihuatl: Dr. O. C. Farrington (Chicago).—List of Mammals from Somaliland: D. G. Elliot (Chicago).—Bæveren i Norge dens Udbredelse og Levemaade: R. Collett (Bergen, Griegs Bogtrykkeri).

SERIALS.—Contemporary Review, September (Isbister).—National Review, September (Arnold).—Scribner's Magazine, September (Low).—The Atoll of Funafuti, Part 3 (Sydney).—Fresenius' Quantitative Analysis, translated by C. E. Groves, Vol. 2, Part 5 (Churchill).—The Atlantic Monthly, September (Gay).—The Fortnightly Review, September (Chapman).—Observatory, September (Taylor).—Geographical Journal, September (Stanford).—Journal of the Chemical Society, September (Gurney). —Imperial University, College of Agriculture, Bulletin Vol. iii. Nos. 2 and 3 (Komaba).—Astrophysical Journal, August (Chicago).

CONTENTS.

THURSDAY, SEPTEMBER 16, 1897.

A SYSTEM OF MEDICINE.

A System of Medicine. Edited by Thos. Clifford Allbutt, M.A., M.D., F.R.S., &c., Regius Professor of Physic in the University of Cambridge. Vol. ii. Pp. xiv + 1176; with 77 illustrations, 6 charts, 1 map, and 1 plate. (London: Macmillan and Co., Ltd., 1897.)

THIS, the second volume of Prof. Allbutt's "System," the first volume of which was reviewed in these columns (NATURE, August 20, 1896), has been delayed somewhat in its appearance owing to a desire on the part of the editor and the corresponding contributors to profit by the results of the Vaccination Commission.

The volume commences with the infective diseases of chronic course, Dr. Sidney Martin contributing the article on tuberculosis, Dr. Phineas Abraham on leprosy, Dr. Acland on actinomycosis and Madura foot. Dr. Martin discusses the ætiology of tuberculosis and the various lesions resulting from tubercular infection; also the varieties of experimental tuberculosis, immunity, and the pathological diagnosis and the prognosis of the disease. Dr. Abraham begins with an historical sketch, and then passes on to the geographical distribution, symptomatology, and pathology of leprosy. The value of Dr. Acland's article on actinomycosis is enhanced by an extensive bibliography which he has added.

The second division of the book is devoted to "Diseases of Uncertain Bacteriology," which are divided into two main classes, "non-endemic" and "endemic or topical." The non-endemic diseases comprise measles, rubella, scarlet fever, varicella, variola, mumps, whooping-cough, and syphilis. The articles on measles and rubella are written by Dr. Dawson Williams, in the latter of which a useful table is given of the differential diagnosis of measles, rubella, and scarlet fever. Dr. Caiger contributes the article on scarlet fever, and under its pathology discusses critically the relation of Klein's scarlatinal streptococcus to this disease. Dr. MacCombie writes the monographs on chickenpox and smallpox. Mumps and whooping-cough are ably treated by Dr. Eustace Smith. Mr. Jonathan Hutchinson writes an admirable medical essay on constitutional syphilis. The author confesses that since 1866, when he wrote the article upon this subject for Reynolds' system, he has changed his views with regard to the power of mercury, when begun early and continued regularly, to prevent the occurrence of secondary symptoms; he says, further, that in his experience patients thus treated usually escape the class of symptoms known as "reminders." With regard to hereditary syphilis, it is of interest that in the author's large experience he has only seen one, and that a doubtful, case of the transmission of syphilis to the third generation. A short article on the coexistence of infectious diseases, by Dr. Caiger, concludes this division of the work.

The "endemic" "Diseases of Uncertain Bacteriology" begin with an essay by Sir Joseph Fayrer, on the climate and some of the fevers of India. The first part of this monograph will be exceedingly valuable to non-professional readers, especially in view of the increased frequency of winter travelling in India, both for health and pleasure. The part devoted to actual disease will be equally useful to practitioners in India, and also to those who practise amongst "old Indians" at home. A valuable bibliography is appended. The articles on dengue, beri-beri, and sleeping sickness are contributed by Dr. Patrick Manson; those on yellow fever and dysentery by Dr. Andrew Davidson. Oriental sore, verruga, and frambœsia are treated by Surgeon-Major Firth.

The third main division of the work is devoted to diseases communicable from animals to man; this, again, is subdivided into those of certain and uncertain bacteriology. The former comprises an article on glanders, by Dr. Sims Woodhead, and one on anthrax, by Dr. J. H. Bell. The second subdivision includes articles on vaccinia, foot and mouth disease, rabies, and glandular fever. The first part of the monograph on vaccinia is contributed by Dr. Acland, and is entitled "Vaccinia in Man—a Clinical Study." The second part treats of the pathology of vaccinia, and is by Dr. Copeman. The third part, "Vaccination as a branch of Preventive Medicine," is by Mr. Ernest Hart. This monograph provides the reader with a complete clinical account of the results of the inoculation of uncontaminated vaccine lymph in man, all that is at present known of the bacteriology, chemistry and morphology of vaccine lymph, and a discussion of the ethics of vaccination.

The article on rabies is by Dr. Sims Woodhead. The author discusses the bacteriology and treatment of the disease at some length. The recent methods of treatment, introduced by Tizzoni and Centanni, and Babes, are discussed, and their advantages over the Pasteur method indicated. The marked difference in the magnitude of the effect produced by antirabic serum according to the seat of inoculation is emphasised by the author. This is of interest from a general point of view as showing that, although the rabic poison itself is in the highest degree selective, *i.e.* wherever introduced, it selects the cells of the central nervous system for the sphere of its action, its antitoxine, although capable of neutralising its effects on these cells, is to a much less degree truly selective, since a much greater effect is produced by it when it is injected into a nerve-sheath on the sub-dural space, *i.e. in situ*.

The next division of the work is devoted to diseases due to protozoa, and includes articles on malarial fever, hæmoglobinuric fever, and amœbic dysentery, by Drs. Osler, Copeman and Lafleur respectively.

The intoxications are next considered. Dr. Sidney Martin contributes an article on poisoning by food—ptomaine poisoning; the author summarises the work of Brieger on the ptomaines. He then describes the Middlesborough epidemic of pleuropneumonia, which was traced to the use of a certain "American bacon." The frequency of *pig's meat* as the offending food stuff in this connection is emphasised; and Dr. Ballard's suggestion that this is connected with the gelatine-producing power of this variety of meat is supported; gelatine being an excellent nutrient medium for many bacteria. The articles on grain poisoning, mushroom poisoning, opium poisoning and other intoxications are from the pen of

X

the editor. In the first article the history, causation, symptoms, diagnosis, prognosis and pathology of ergotism are fully considered. Under diagnosis the author discusses the identity of ergotism and Raynaud's disease. Descriptions of pellagra, the disease due to bad maize, and of lathyrism, that ascribed to certain species of chick-pea, conclude the article. The monograph on snake poison and snake bite is written by Mr. Martin, an appendix being added by Dr. Calmette. Mr. Martin discusses the chemical nature and physiological action of several snake toxines. In his opinion the albumoses, which form the active principle of snake poisons, are produced by the glandular cell from the albumins of the blood by a process of hydration. Dr. Calmette, in his appendix, gives the latest results of his antivenom treatment. He (in opposition to Martin) maintains the efficacy of treatment by hypochlorite of lime, and also by chloride of gold (1 per cent.), which he recommends when antivenom is not to hand. His view is that the antivenom acts by an "insensibilisation" of the cells, and cannot be regarded as *chemically* antidotal. Calmette maintains that animals rendered immune by vaccination against a dose of Cobra or Bothrop's venom many hundred times the ordinary fatal dose, resist likewise inoculations of very powerful doses of the venom of numerous other serpents. Readers interested in this subject are referred by the editor to an article in NATURE (December 10, 1896), by Dr. Kanthack, which gives an account of further researches by Dr. Cunningham and himself upon this subject. Dr. Rolleston contributes an article on alcoholism, in which the approximate composition of the more ordinary alcoholic drinks is considered. On p. 846 of this monograph occurs an amusing misprint—the only one we have noticed—Kirschwasser being written "Kirchwasser." Morphinism, hasheesh poisoning, cocainism, ether drinking, and tobacco poisoning are all fully treated by the editor. Dr. Thomas Oliver contributes a monograph on metallic and some other forms of poisoning, including "poisonous trades."

The final division of the work is devoted to internal parasites. It includes articles on psorospermosis, by Dr. Joseph Griffiths; on worms, by Dr. Patrick Manson; on Bilharzia hæmatobia, by Dr. Guillemard; on hydatid disease, by Dr. Verco and Prof. E. C. Stirling.

The editor has adopted the useful system of placing at the end of vol. ii. addenda containing any important additions to our knowledge of the subjects already written upon, since the completion of the respective monographs. In this instance Dr. Sheridan Delepine writes a description of Widal's typhoid serum reaction. Dr. Payne summarises the ways in which the recent plague epidemic has increased our knowledge of the geographical distribution and therapeutics of that disease. Dr. Davidson discusses Sanarelli's yellow fever bacillus, and protective serum.

It is impossible in a review such as the present one to do justice to the encyclopædic mass of information which is contained in the volume before us. The editor and his collaborators are, however, heartily to be congratulated upon this further result of their labours, which both in matter and manner may be regarded as a model of what such a work ought to be. F. W. T.

ANTHROPOLOGY versus ETYMOLOGY.

Modern Mythology. By Andrew Lang. Pp. xxiv + 212. (London: Longmans, Green, and Co., 1897.)

READERS of NATURE will remember that it is not many weeks ago since Prof. Max Müller's "Contributions to the Science of Mythology" was reviewed in these columns. It is not many weeks, in fact, since this work appeared, and any serious student of the subject with which it deals will have hardly yet assimilated the mass of new material and varied suggestion which, so short a time ago, it presented to his notice. Such a student taking up "Modern Mythology," and turning to the introduction, will experience a shock of surprise on finding that Mr. Lang's new book poses as "a reply" to the learned Professor's portly volumes. The puzzled student asks himself how any adequate "reply" can have been written, printed and published in so short an interval, and his surprise that such a feat has been attempted changes to regret when he passes from the introduction to the book itself. That Mr. Lang has formulated this hasty indictment is the more to be regretted as he speaks throughout as the champion of the anthropological treatment of mythology; but it must be noted that he is a self-constituted champion, and we may be forgiven for saying that we think he has miscalculated his own importance in that field of science. We willingly accept his assurance that he does know Greek, but we cannot remember that he has anywhere shown that he possesses the masterly knowledge of oriental and other languages possessed by Prof. Max Müller, or that he has a knowledge of scientific anthropology equal to that of Prof. E. B. Tylor and the other great masters of the same school to whom he, in common with ourselves, is really indebted for the main facts and principles of anthropology which he accepts. We admit at once that the greatest linguist is not always the best interpreter of the facts which he has gleaned from the literatures of the various nations with which he is acquainted. But we must at the same time declare that a man who sets himself up to interpret the facts which the linguist has collected, should at least have sufficient knowledge of the language to understand the facts and to discern the reasons which induced the linguist to make his statements.

It cannot be denied that to the older school of mythologists, which counts Prof. Max Müller its most brilliant exponent, was due the first scientific treatment of the subject. They were concerned solely with the mythology of Greece, but they were the first to perceive that the stories of gods and heroes were worthy of classification and systematic study. Their conception of mythology may be briefly described. The Greek gods and goddesses, they postulate, were in their origin merely personifications of the great forces and most striking phenomena in nature. Their names were originally descriptive of their general character as natural forces, and the myths which gathered about them were merely allegories describing, in the form of stories, the working of these forces in the natural world. But in process of time the names of the deities ceased to be understood, and the original meaning of the myths was forgotten.

Popular explanations of the divine names obtained currency and modified the myths. Thus the old name of a deity which had lost its meaning might remind a later generation of the name of some beast; hence might arise those stories of gods taking the forms of beasts and acting like them, which are mixed up with and mar the lofty and poetical character of Greek mythology. To this school mythology is, in a sense, "a disease of language," and can be explained best by means of etymology. Their method consists in extracting the original meaning of Greek divine names by a comparison of Sanskrit roots. Having by this means obtained an inkling of a deity's origin, they proceed to explain the myths connected with him in accordance with his character.

The younger school of mythologists proceed on totally different lines. They do not confine their studies to the mythology of one nation or one family of nations, but examine and classify myths all the world over. They regard the savage stories of Greek gods and heroes not as due to a disease of language, but as survivals from an age of more primitive culture, tracing their origin to certain human peculiarities shared by all races in the early stages of their development. To the mind of the savage, nature is not inanimate; every animal, plant, stone, wind and river he regards as having a life and personality like his own, and attributes to them human powers of thought, speech and action. Moreover, the bounds which mark off the various subdivisions of the natural world are not drawn tight for him, but he regards all things as capable of endless change of form; thus gods may become men, and both gods and men may become beasts or things. When, therefore, stories of gods assuming bestial shapes occur in Greek mythology, the anthropologist regards them not as later developments due to a mistaken etymology of names, but as relics of an earlier state of culture.

Such, broadly stated, are the differences in theory and method between the two rival schools of mythologists, of which the anthropological school will always be preeminently associated with the name of Prof. Tylor. In "Modern Mythology" wherever Mr. Lang sings the praises of this method we entirely agree with him; but anthropology is now a sturdy infant, and in no danger of being ignored. That part of the book which deals with Mr. Lang's own utterances and those of Mannhardt, Prof. Tiele and others, though wittily and charmingly written, is not of very great importance, and might well have appeared in the form of two magazine articles; a fate, by the way, which had already befallen the last quarter of Mr. Lang's book. In such a guise Mr. Lang's "reply" would have amused and delighted us, for he has the enviable power of writing attractively on the surface of any subject, however abstruse. When, however, a clever but rambling collection of notes, thrown together in a few days, would pass as a serious reply to the ripe work of many years of scholarly labour, we could wish, in the interests of science, that its author had been a man of less eminence or greater discretion.

OUR BOOK SHELF.

The Vivarium: being a Practical Guide to the Construction, Arrangement, and Management of Vivaria, containing full Information as to all Reptiles suitable as Pets, how and where to obtain them, and how to keep them in health. By Rev. G. C. Bateman. Pp. 424; illustrated. (London: L. U. Gill.)

THE main title of this little work is likely to give the impression that it merely treats of the best way of keeping a few reptiles or other creatures in a fern-case in a window or conservatory. But it is really much more than this, and gives details of the manner to keep in confinement and health, not only small lizards, salamanders, and snakes, but likewise such inconvenient "pets" as alligators, pythons, and boa-constrictors—creatures by no means suited to the *ménage* of every small household. Nor is this all, for it is practically a natural history of reptiles and amphibians, although attention is chiefly directed to those species most easily obtainable in the market, and which thrive best in confinement. The illustrations are, for the most part, of a high class, and the descriptions of the various animals well written, although, perhaps, at times a trifle dull. The instructions for making vivaria appear complete, and the hints on management all that can be desired.

A fair criticism on the book is that it is either a little too scientific, or not quite scientific enough. That is to say, the author is often too scientific for ordinary readers, while naturalists would go elsewhere for the information he seeks to impart. In the general arrangement of reptiles an obsolete classification is adopted, while in the case of genera and species the author is often undecided as to what names to adopt. When both names are given side by side not much harm is done, but when we find the common viper figuring as *Pelias berus* on p. 3, and as *Vipera berus* on p. 170, the beginner is likely to feel a trifle puzzled. Then, again, what is the use of giving abbreviations of authors, such as Dum. and Bibr., after the names? Hieroglyphics or logarithms would be just as comprehensible to the readers who are likely to study the book! It would, perhaps, be severe to suggest that the author's classical knowledge is a little shaky; but it is certainly new to us that *Ichtys* (p. 4) is the Greek for a fish, or *Orphis* (p. 5) for a snake! Probably the long-suffering printer will be blamed.

Many amusing anecdotes are introduced into the book, and even professed naturalists will now and then find something in regard to habits which may be novel to them; the account of the development of axolotls into salamanders being specially good. We observe that the author maintains an undecided neutrality on the subject of vipers swallowing their young, although the anecdote he relates of a live lizard appearing suddenly from a snake's mouth after a sojourn of some four-and-twenty hours, might perhaps have given grounds for thinking that there is a germ of truth in the legend. To those desirous of knowing something about reptiles and amphibians, and, above all, to those venturesome persons who are ambitious to have tame pythons and crocodiles about their houses, the book may be commended.

R. L.

Geological Survey of Canada. Annual Report (New Series), vol. viii., 1895. Pp. 998. (Ottawa: Printed by S. E. Dawson, 1897.)

THIS fine volume of nearly one thousand pages is accompanied by six maps and illustrated by seventeen plates, besides a number of figures in the text. It is a record of work accomplished during 1895, and its pages show that the progress made in that year was both satisfactory and important.

Dr. G. M. Dawson, F.R.S., the Director of the Survey,

gives a valuable summary of the explorations and surveys made in 1895, and the museum and other work carried on under his direction. The separate reports contained in the volume are as follows :—

"The Country between Athabasca Lake and Churchill River," by J. Burr Tyrrell and D. B. Dowling.

"The Geology of a Portion of the Laurentian Area lying to the North of the Island of Montreal," by Frank D. Adams.

"Explorations in the Labrador Peninsula, along the East Main, Koksoak, Hamilton, Manicuagan, and portions of other Rivers, in 1892-93-94-95," by A. P. Low.

"Report of the Section of Chemistry and Mineralogy," by G. C. Hoffman.

"Report of the Section of Mineral Statistics and Mines," by E. D. Ingall.

These reports are published separately, and several of them have already been referred to in our columns of "Notes."

A Bibliography of Science. By William Swan Sonnenschein. (London : Swan Sonnenschein and Co., Ltd., 1897.)

THIS classified list of scientific books, extracted from two useful bibliographies prepared by the author a few years ago, will be valuable to readers who are outside the living stream of scientific thought. It is in no sense complete, and it does not pretend to be so ; nevertheless, it will serve a useful purpose. Some of the remarks of the editor may be resented by the authors of the books referred to. Thus, one book is described as "a somewhat slovenly and unscientific performance" (p. 384). If the criticism is a just one, the title of the book might have been omitted.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Zeeman's Phenomenon.

IN Section A at the Toronto meeting of the British Association, Dr. Lodge raised the question as to whether we should expect on a simple theory that the spectral lines should be simply widened or be doubled by magnetic force. The simple theory depends on the acceleration or retardation of electrons performing circular orbits under the action of a magnetic force normal to the plane of the orbit. If the plane of the orbit be not normal to the magnetic force, it might appear that the acceleration or retardation would be only that due to the component of the force normal to the plane of the orbit. From this it would follow that the lines would be *widened* and not *doubled*, because every intermediate acceleration or retardation would occur between the extreme cases of orbits perpendicular to the magnetic force. This suggested theory, however, overlooks the effect of the magnetic force in altering plane of the orbit. The complete theory can be very much more simply obtained by another method of attack. The motions being assumed simply periodic in the undisturbed motion, can be resolved for each electron into three linear vibrations, two at right angles to the magnetic force and one parallel to it. This latter is undisturbed and gives no light in the direction of the magnetic force. Each of the other linear vibrations is disturbed, and we can easily see how by considering that a linear vibration may be considered as due to two circularly polarised vibrations. Each of these component circular vibrations will be altered by the magnetic force normal to its plane, one being simply accelerated and the other retarded. We can consequently see that this more complete theory leads to the conclusion that the lines would be *doubled* and not *widened*, though, of course, they may be also widened owing to other disturbances of the motion. There would be no difficulty in writing down the equations of the resulting motion of the electron, but it seems hardly necessary to do so, as this geometrical analysis leads to the kind of vibration emitted, which is all that we can observe. GEO. FRAS. FITZGERALD.

Fort William, Ontario, August 28.

Coccoliths in our Coastal Waters.

ALTHOUGH much has been written about the problematical coccoliths, the presence of these bodies in our coastal waters does not appear to have been recorded. Our observations on the minute marine organisms off this coast (South County Dublin) show that they abound both near the shore and outwards to the limits we have hitherto investigated--some three miles into the Irish Channel.

The following preliminary account of their mode of occurrence, and some features of their structure may be of interest.

Our first finds were effected by means of a cone-shaped, metal, surface dredge; the wide end guarded with wire gauze—about fifty meshes to the linear inch—and the narrow truncated end closed with fine brass gauze, having about 350 meshes to the linear inch. The dredge is floated horizontally by pine-wood wings, and when in operation is trailed behind a boat, the wide end forwards. At intervals the dredge is lifted, the finer gauze removed and washed in a little sea water.

Examination of the fine particles so gathered reveals many varieties of foraminifera, diatoms, a great abundance of peridineæ, sponge spicules, &c., and an amœboid body resembling

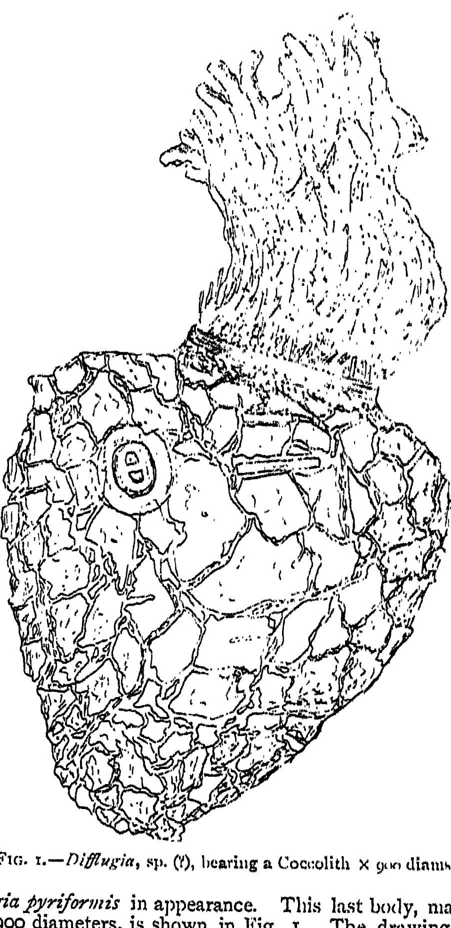


FIG. 1.—*Difflugia*, sp. (?), bearing a Coccolith × 900 diams.

Difflugia pyriformis in appearance. This last body, magnified about 900 diameters, is shown in Fig. 1. The drawing shows the organism as freshly dredged and extending finger-shaped pseudopodia from the open collar, which terminates one extremity of its urn-shaped case. Most usually it is observed with the pseudopodia retracted.

The case enclosing the protoplasm is composed of minute grains of quartz sand (resist acids and alkalies), adhering in random fashion to the protoplasmic contents within. Also there will be seen in the figure (which is from a camera-lucida drawing) one small oval body, occurring among the sand grains.

Reference to Dr. Murray's well-known figure of the coccoliths gathered from the surface waters of the North Atlantic, at once shows the close resemblance of both bodies. In a certain focal plane, indeed, the resemblance is even still more striking. Dr. Murray's drawing is reproduced in Mr. G. Murray's and Mr. Blackman's article appearing in NATURE, April 1, 1897, p. 510. It is of interest to note that Bütschli records the appearance of disc-shaped plates of uncertain origin in *Difflugia*.

The number of *Difflugia* present in our slides is very considerable, and of this number perhaps some 25 per cent. show one or two implanted coccoliths. Furthermore, the *Difflugia* are by no means confined to the immediate surface. Sinking our dredge to a depth of eight fathoms in Killiney Bay, we still obtained this organism; and varying states of wind and tide did not appear to affect its numbers.

The first question that arises is as to the relation which the minute adherent organisms bear to the *Difflugia* which carry them. The surmise naturally arrived at was that the relationship is accidental. The protozoan gathers its covering particles from such minute hard bodies as it finds convenient; among them it occasionally picks up an organised particle—the coccolith.

If this surmise as to the relations of the two organisms is correct, it must follow that examination of the most minute solid constituents of the sea water will reveal the presence of free coccoliths in considerable numbers. To test this question, some two litres of sea-water was permitted to stand twenty-four hours in a tall narrow jar; the upper part being then syphoned off, leaving some 200 c.c. of the lower portion. This was then treated in a centrifugal apparatus, readily fitted on a small dynamo, permitting a high rate of rotation. In this manner the water was cleared in a very short time of all turbidity, and a mat composed of its solid contents thrown to the bottom of the tubes of the centrifuge.[1]

Examination of this precipitated material showed at once that coccoliths in a free state abounded in the water, every slide showing not less than a few score of specimens. Fully provided with specimens thus favourably placed for observation, we were enabled to confirm our previous observations as to the structure and probable composition of these bodies.

As full details are hardly in place here, we will refer at once to Fig. 2 for perspective appearances of the organism. The figures are more in outline than our original drawings, to permit of more ready reproduction in these pages. Figs. *a* and *b* are perspective views of opposite faces of the valves. Fig. *c* is an edge view. We explain the appearances presented in these drawings with considerable confidence by the diametral section shown in Fig. *d*. The coccolith consists of two very thin, funnel-shaped, elliptical valves; a small valve attached by a central connection within a wider, and provided with minute radial striations sculptured apparently on the outer or convex surfaces of both valves; between forty and fifty striations going round the valves. The connection attaching the valves is rounded or slightly oval and apparently perforated axially by two D-shaped apertures, but occasionally a single oval opening traverses the collar; or, again, the cross-piece separating the D-openings appears incomplete, and is represented by projections extending into an oval opening. The more minute structure of the connecting neck or attachment is unknown to us. The valves are frequently found chipped and fractured, but, so far as observed, always rigidly connected one with another. Specimens considerably less in dimensions than the normal are occasionally found, but identical in form. The resemblance between our drawings and those given by Bütschli in his *Protozoa* (Plate 1, Figs. 2-5) at once confirms the view that these organisms are identical with those described by this authority as "Coccolithen." The organism is a most difficult and illusive object owing to its minuteness, transparency and complex structure. Our drawings are made with a 1/12 oil immersion of Leitz.

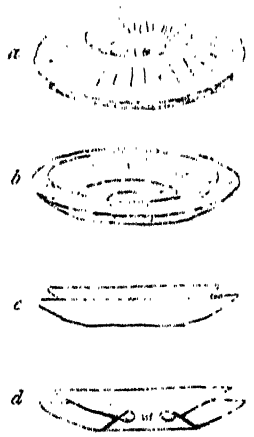


FIG. 2.—Coccolith × 2000 diams. q.p.

The coccoliths dissolve freely in dilute hydrochloric acid, and are partially and much more slowly attacked by strong caustic potash. The latter reagent does not appear to be able to completely dissolve the central parts, more especially of the lesser valve; or at least cannot do so with any celerity. The absence of the appearance of free gas upon attack with the acid hardly negatives the idea—agreeable with the observations of Dr. Murray and others—that these bodies are calcareous. In all these tests we have frequently had well-characterised diatoms present in the same field, and whereas the characteristic silicious covering of the latter held out against the acid, the coccolith immediately dissolved. In the application of the caustic potash test diatom valves were also present, and these showed complete resistance to the caustic alkali.

That there is some living matter present between the valves appears suggested by the granular appearance often presented in the ring embracing the central connection, and also by the fact that upon solution in dilute acid just such a ring of granular particles is thrown down, and alone remains to mark the spot where the coccolith had been. This granular remains assumes a tawny yellow or brownish colour when acted on by iodine. The inference is that a ring of (residual?) protoplasmic matter surrounds the central connection of the valves. Neither nucleus, flagellum, pseudopodia, nor cilia have as yet been observed, neither have we found any evident chromatophores.

In the present stage of our inquiry we can only ask with considerable uncertainty as to the nature and affinities of this interesting organism. Its rigidly attached valves, absence of girdle, and the calcareous nature of the valves, negative, we think, the idea that it is—as sometimes assumed—of diatomaceous nature. Its relationship with the Foraminifera is more probably suggested.

The possibility that they are commensal with, or parisitic on, the protozoan which so often carries them, must not be forgotten; at the same time our abundant free specimens appear so often ringed between the valves with proteid matter, that their independent existence appears highly probable. There is at present hardly data sufficient to render them referable with certainty to either one or the other kingdom of organised beings.

It may be assumed that they are abundant in our coastal waters as well as in the open ocean, where they in certain places bear a part in the formation of the Atlantic ooze. These circumstances, as well as their geological importance, confer great interest on the problem of their life-history—a problem the solution of which we do not think need be despaired of where such abundant materials are at hand.

J. JOLY.
H. H. DIXON.

Dalkey, August 27.

P.S.—Since the above was written we have found a few coccospheres in the water off this coast. These appear very scarce compared with the abundance of coccoliths. The abundance of the latter is remarkable. A sample of water taken some three miles from the shore on a calm day afforded, according to an estimate made with a divided stage, 200 coccoliths in each cubic centimetre of the sea-water! If this abundance obtains at other points along our coasts (we hope shortly to have results bearing upon this question), they must be one of the most abundant organic constituents of our seas.

We have found many specimens of the free coccoliths with a slimy proteid (?) attachment to the smaller valve.

Between crossed nicols the thin flange of the larger valve appears inactive; the entire inner ellipse, on the other hand, shows a dark-cross, the arms in some cases revealing a certain amount of spiral bending. A concentric and crystalline structure is thus suggested.

J. J.
H. H. D.

September 9.

A Bright Meteor.

ON Monday evening, the 6th inst., at 7.49 p.m. (Dublin time), I was walking from Blackrock to Dublin on the Blackrock road, and when passing by Booterstown I saw a very fine meteor of a brilliant white (such as the magnesium light) pass across the sky under the Plough at a slow rate, the course being parallel to the two lower stars of the four forming the Plough, and about the distance between the two "pointers" under it. It covered a flight of about 10° to 12°, and disappeared at a point about 15° to 20° above the horizon.

Dublin, September 9. J. P. O'REILLY.

[1] Later we netted them on silk in abundance.

The Centipede-Whale.

BESIDES the passage in Aelian about the *Scolopendra cetus*, quoted in your paper of September 9 by Mr. Minakata, there are epigrams of Theodoridas of Syracuse, and Antipater of Sidon (third and second centuries B.C.), referring to something of the sort. Aristotle's marine *Scolopendra*—a small animal—is, of course, not in point. W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, S.W., September 10.

NOTES.

ON the formation of the British Section of the Pasteur International Memorial, the Secretary, Prof. Percy Frankland, F.R.S., forwarded a circular to India, and invited admirers of Pasteur there to form an Indian Section for the collection of contributions. Surgeon Major-General Cleghorn, who undertook the secretaryship of this section, has now transmitted a list of subscribers together with the substantial sum of 442*l.* 17*s.* 3*d.* to be sent on to Paris. Amongst the centres which have forwarded contributions we find Bengal, Madras, Bombay, the Punjab, Central India, Central Provinces, North-west Provinces and Oudh, Assam, Burma, Rajputana, Berar, and Baluchistan; thus indicating how widely appreciated the services of Pasteur are in our Indian Empire.

REFERRING to the ascent of Mount St. Elias, which was accomplished by the Duke of the Abruzzi (Prince Louis of Savoy) and his companions on July 31, the New York *Nation* remarks:—The two facts of special significance to which the dispatches announcing Prince Louis' success call attention are: the determination of the mountain's altitude, and the demonstration that it is not of volcanic origin, but simply a mass of elevated and partially upturned sedimentary strata, largely fossiliferous in character. The altitude, as computed by the mercurial barometer, is 18,060 feet, a result surprisingly in accord with the determination, by angle measurement, of Prof Russell, who obtained "18,100, plus or minus a probable error of 100 feet." Earlier measurements of the mountain ranged from less than 13,000 feet (La Pérouse, in 1786) to approximately 19,500 feet (Dall, 1874). It is probably safe to accept the present measurement, which places St. Elias—barring a possible excess in favour of the neighbouring Mount Logan—as the second mountain in point of elevation on the North American continent, the place of honour belonging to the Citlaltepetl, the Star Mountain—better known as the Peak of Orizaba—of Mexico, to which the determinations of Heilprin (1890, aneroid), Scovell (1891, triangulation), and Kaska (1897, mercurial barometer) give 18,2(3)00 feet. The non-volcanic nature of Mount St. Elias had already virtually been determined by Prof. Russell, but it will be a satisfaction to geologists to know that Prince Louis' studies of the mountain for the 4000 feet left untouched by Russell confirm this investigator's general conclusions.

MR. J. E. DUERDEN, Curator of the Jamaica Institute Museum, has sent us a short account of the researches in marine biology carried on this year at Port Antonio by students of the Johns Hopkins University, under the direction of Prof. J. E. Humphrey. A number of important investigations were advanced, and the material collected by the party will, no doubt, form the basis of important contributions to natural history. Prof. J. E. Humphrey studied and collected material in connection with the structure and development of plants of various groups.—Dr. F. S. Conant visited Jamaica this year to continue investigations begun by him last summer upon the *Cubomedusæ*, a rare group of jelly-fish of which two species have been found in extraordinary abundance in Jamaican waters.—Dr. H. L. Clark continued the work which he began last summer on the Echinoderms (star-fish, sea-eggs, sand-dollars, sea-cucumbers, &c.) of the island, giving especial attention to the Holothurians or "sea-cucumbers"—forms of life which are very abundant around Jamaica.—Mr. Sudler, who was also a member of last year's party, continued the collection of material exhibiting the metamorphosis, or changes during the life-history, of *Lucifer*, one of the small Crustacea which shows some very important developmental features.—Mr. Grave worked upon the sea-stars or Ophiurians, and collected twelve or more species, only five of which have been previously recorded from Jamaica. The eggs of one of the species were artificially fertilised in the laboratory, and a complete series of the embryos, from the single cell to the fifteen-day Pluteus stage, has been preserved and will be further studied.—Mr. E. N. Berger devoted his time mostly to the Insects, Arachnids (spiders, scorpions, &c.), and Myriapods (centipedes and millipodes), paying special attention to the pseudoscorpions. The pseudoscorpions are small animals, the largest collected not measuring over three-sixteenths of an inch in length. A few specimens of a second species of pseudoscorpion, smaller and more active than the first-mentioned, were collected. One interesting point determined is the building of a small nest from fragments of rotten wood, the nest being evidently lined by the animal with a fine silk when about to shed its skin. The embryo lies as if dead in this little nest, and after a time emerges with its appendages of a very pale green, which later turns to the normal brown. Little is known of the development of the pseudoscorpions, and it is expected that the material collected will aid in throwing some light on the group.—Mr. Duerden devoted himself to the Actiniaria in furtherance of the work already carried out on the south side of this island. A new species of *Bunodeopsis* was discovered, several previously obscure species were recovered, and a supply of embryological material preserved for further research.

WITH the foregoing account of this summer's work in the Johns Hopkins marine laboratory, comes to us the news of the death of Prof. Humphrey, who was in charge of the students at Port Antonio. Prof. Humphrey was only a little over thirty years of age, but his scientific works had stamped him as a botanist of much promise. He was associate professor of botany at the Johns Hopkins University, Baltimore. He graduated at Harvard University some years ago, taking the degree of Sc.D. It is significant of the position he held in the estimation of his American colleagues, that he formed one of the Botanical Commission which lately visited Jamaica to determine the best site for a botanical station. A few years ago he paid a visit to the island in connection with the Johns Hopkins University, to investigate the fauna. During the recent sojourn, which has ended so disastrously, he devoted himself principally to collecting embryological material for the benefit of his students at Baltimore, and especially material of the shell-boring algæ in reference to which he had already published his researches. His death will be deeply regretted in the botanical world.

FROM an obituary notice in the *Lancet* we have obtained the following particulars of the work of Dr. J. Braxton Hicks, F.R.S., whose death we announced last week. Dr. Hicks was born in 1823. He obtained the M.D. of the University of London in 1851, and in the following year was elected a Fellow of the Linnean Society. Ten years later he was elected to the Fellowship of the Royal Society. To medical and scientific journalism Dr. Braxton Hicks was a valued and voluminous contributor; he also published many papers in Italian, American, and Australian medical journals. From his boyhood upward he was a devoted student of natural science, and he published a number of papers on original subjects in the *Proceedings* of the Royal Society. Among these may be noted "Eyes of the Invertebrata" and "Supplementary Forces concerned in the Circulation of the Uterus." To the *Transactions*

of the Linnean Society he contributed many papers on zoology and botany, and described many groups of sensory organs on the surface of insects. In the same *Transactions* he also published papers on original researches on the "Lichens, Mosses, and Unicellular Algæ"; and papers on "Volvox Globator, Amœboid Vegetable Bodies," and "Gonidia of Lichens" were contributed by him to the *Microscopical Journal*.

THE meeting of the Australasian Association for the Advancement of Science, to be held at Sydney next January, promises to be an important one. A large number of papers have been promised to the different sections, among them being: "The Classification of Eucalypts," by J. G. Luckmann; "A Statistical Account of Australian Fungi," by D. M'Alpine; "The Algæ of Victoria," by H. T. Tisdell; "Flowers of the Order Proteaceæ," by J. Shirley; "Underground Fungi of Tasmania," by R. Rodway; "Australian Oceanography," by T. W. Fowler; "On the Formation and Structure of Coral Reefs," by J. J. Wild; "The Dialectic Changes of the Indo-Polynesians," by the Rev. S. Ella; "The Oceanic Peoples," by E. Tregair; "The Ancient Geography of the Maoris," and "The Geographical Knowledge of the Polynesians," by S. Percy Smith; "Old Samoa" and "Australian Cave Paintings," by the Rev. J. B. Stair; "Ancient Maori Rites and Customs," by Mr. Elsdon Best; "The Teaching of Mechanical Drawing in State Schools," by J. Plummer; "The Characteristics of Australian and other Diamonds," by E. W. Streeter; "A Series of Microphotographs of Bacteria," by Dr. Frank Tidswell; "The Rationale of Miraculous Cures in Modern Days," by Dr. S. T. Knaggs; "Fact and Idea," by J. C. Brennan; and "Scientific Methods as applied to Modern Education," by Miss E. A. Badham.

THE death is announced of Mr. John Darlington, a well-known mining engineer, and author of a number of works on mining and metallurgy.

THE sixteenth annual congress of the Sanitary Institute opened at Leeds on Tuesday, and the President, Dr. Farquharson, M.P., delivered an inaugural address.

THE eighth annual meeting of the Federated Institution of Mining Engineers was held on Tuesday in Edinburgh, under the presidency of Sir Lindsay Wood.

THE energetic Secretary of the Society for the Protection of Birds has issued another letter of protest against the wanton destruction of birds to supply ladies with wings and feathers and stuffed skins for their bonnets. The Society is unceasing in its efforts to open the eyes of the gentler sex to the cruelty often practised in procuring plumes, and to the gradual extermination of many beautiful and beneficial birds. We regret to think, however, that such trifling matters do not disturb the minds of the majority of women when they choose their millinery. Present effect is to them the sole criterion of the value of a bonnet, and how the effect is produced they complacently leave others to inquire.

ATTENTION has already been called to the fact that the collation of the enormous mass of evidence collected by the Indian Geological Survey with regard to the great earthquake of June 12, is now being carried on under the supervision of Mr. R. D. Oldham. It is as yet too early for any final opinions to be expressed, but some of the preliminary results are of interest as showing the power of the shock. The area affected is stated to be greater than that of the Lisbon earthquake. The earlier reports as to the damage were exaggerated; but it was nevertheless very serious, as can be readily believed, as the cylinder seismometer at Shillong indicates that the shock consisted of an oscillation of 7·4 inches at the rate of 60 times a minute. All the masonry was accordingly simply shattered to pieces, rather than overthrown. Mr. Oldham's conclusions as to any possible connection between the earthquake and a continued uplift of the Himalaya will be awaited with much interest.

THE systematic position of the Dictyotaceæ has been a frequent subject of inquiry among algologists. The occurrence of tetrasporangia and of non-motile male cells has even led some to suggest an affinity with the Florideæ. Crouan was, however, of opinion that the so-called spermatia were motile; but Thuret, after a careful investigation, concluded that they were, like the similar bodies in the Florideæ, devoid of cilia, and incapable of movement. Later Johnson thought he saw evidences of ciliary movement in *Dictyopteris*, another genus of the same family. Mr. J. Lloyd Williams has now clearly established by repeated observations, carried on during this and last summer, that the antherozoids of *Dictyota* and *Taonia* are actively motile like those of Fucaceæ. It is evident that this is an observation of great importance, and botanists will look forward to the publication of details. The work has been conducted in the Botanical Laboratory of University College, Bangor, the situation of which on the shore of the Menai Straits afforded excellent facilities for the investigation.

THE wonderful expansion of mining enterprise in the West Kootanie district of British Columbia during the past few years, and the extent and richness of the deposits carrying silver and gold there, are referred to by Dr. G. M. Dawson in the latest Report (vol. viii., 1895) of the Geological Survey of Canada. One of the most noteworthy points brought out by the field-work of Mr. McConnell is the occurrence, lately ascertained, of ores of exceptional richness in parts of the granite area, which has hitherto been almost disregarded by the miners. In the Rainy Lake and Thunder Bay districts of Western Ontario, surveys have been made by Mr. McInnes in connection with the development and definition of the auriferous quartz veins and iron ores. The rocks characterising the country are divisible, in a general way, into Laurentian and Huronian; and it is in the latter that minerals of value are found to occur. Dr. Dawson states that some assays of quartz from the Manitou and Seine River regions prove the existence of quartz-veins exceptionally rich in gold, of which it only remains to determine the extent and continuance in depth. A survey of the Noddaway River in Northern Quebec, by Dr. Bell, resulted in the important geological discovery that a great area of the Huronian system exists to the north of the main watershed.

A SIMPLE experiment for determining the source of the rays from a "focus" tube is described by Dean Molloy in the *Scientific Proceedings of the Royal Dublin Society* (vol. viii. part v. 59). Dr. Molloy took a deal board measuring seven inches by five, and into it drove fifteen slender nails in three rows of five; this was attached to the back of a fluorescent screen mounted on a stand so contrived as to allow of the apparatus being revolved in a circle about the focus tube, with the screen always tangential to the circle. By noting the directions of the shadows of the nails, the exact position of the source of radiation could be determined. On adjusting the focus tube so that the central nail pointed towards the platinum plate in all positions of the screen, it was found that this nail gave only a black spot for its shadow, the shadows of the other nails radiating symmetrically from this spot as centre. It followed that the source of radiation was in the line of the central nail produced, and was thus shown to be at or about the centre of the platinum plate. Dr. Molloy then proceeded to determine the size of the area of radiation by means of a pin-hole image, and found it to be an irregularly circular ill-defined patch about a quarter of an inch in diameter, coinciding with the patch which first begins to glow when the current is turned on.

IN the *Atti dei Lincei*, vi. 4, Prof. Domenico Mazzotto gives a continuation of his observations on the electro-magnetic indices of refraction of woods. The object of the new experiments was to ascertain whether the principal indices of refraction were proportional to the square roots of the dielectric constants in the same directions, in accordance with Maxwell's theory. In the case of beech (and presumably other woods) this relation was found to be satisfied. On drying the wood, both the dielectric constants and the indices of refraction diminished correspondingly.

IN the *Rendiconto* of the Naples Academy (iii. 7), Dr. R. V. Matteucci announces the discovery for the first time of the elements iodine and bromine among the products of the fumaroles of Vesuvius. It will be remembered that only quite recently the same author discovered selenium in a similar locality.—Prof. Domenico de Francesco gives an elegant mathematical investigation of the equations of vertical motion of a balloon in free air on the assumption of Newton's law of resistance.—Prof. E. Villari gives a note on the discharging property produced in gases by certain compounds of uranium, first discovered by Becquerel.

SEVERAL partial accounts of Prof. Vicentini's valuable microseismograph have already appeared, but for the first time a complete description is given in a memoir by Dr. G. Pacher (*Atti del R. Ist. Veneto di scienze*, t. viii., 1897, pp. 1-62). The instruments described are the original form of the microseismograph, in which the length of the pendulum is 1·5 m., and its mass 100 kg., and the latest form, in which the length is 10·7 m. and the mass 408 kg. Detailed instructions are given for erecting the apparatus in a suitable place, for putting the different parts together, preparing the smoked paper, &c. There are also brief accounts, with useful bibliographies, of other instruments, such as the horizontal pendulums of von Rebeur-Paschwitz and Milne, the bifilar pendulum of H. Darwin, the vertical pendulums of Agamennone and Cancani, and the geodynamic levels of Grablovitz.

A PHYSICAL theory of the electrical phenomena of the higher atmosphere is briefly described by M. Marcel Brillouin in the *Revue Générale des Sciences* (August 30). It is now well known that any metallic body charged negatively, loses its charge when exposed to ultra-violet light. Experiments carried out in the physical laboratory of the École Normale in Paris have shown that dry ice behaves like a metal, when charged with negative electricity and exposed to ultra-violet radiations. When the ice has a film of water upon it, however, the loss of electricity is extremely small. As cirrus clouds consist of ice needles, and receive ultra-violet radiations from the sun, negative electrification may pass from the needles into the surrounding air, leaving the cloud particles charged positively. This is the basis of the theory, which is summed up by M. Brillouin as follows: (1) atmospheric electricity is produced by the action of ultra-violet solar radiations upon the ice needles in cirrus clouds; (2) the initial electrical field is produced by the movements of the higher regions of the atmosphere relatively to the earth's magnetic field.

THE *Bulletin de la Société de Geographie* contains a suggestive paper by Prof. J. Thoulet on the great need for better maps of the seas and oceans. Maps of those regions are no longer exclusively of interest to the navigator—almost every scientific man is now more or less concerned with oceanography in some of its aspects, and every day raises new practical problems connected with cables, fisheries, submarine mines, &c.—nevertheless the best accessible sea-maps are small of scale and mostly out of date. Oceanographers know that the average current-chart, faithfully copied from one atlas to another, is a disgrace to modern knowledge, but it may be doubted if the time is yet ripe for an elaborate "Sea Atlas" of large-scale maps. The scheme proposed and ably worked out by Prof. Thoulet in the second part of his paper cannot, however, be undertaken too soon. It is proposed, by careful drawing of lines on the large-scale charts, to prepare accurate contour maps of the whole of the sea-bottom within 200 metres of the surface, and then, by enlisting volunteer observers, to collect sufficient material to allow of accurate lithological classification of the deposits on the continental shelf. The distribution of these deposits could be shown by colouring on the contour charts, and we should thus be put in possession of an accurate representation of the relief and geological formation of one of the most interesting and important regions of the globe. Prof. Thoulet suggests that the deposits should be arranged under four headings: "sand," "muddy sand," "sandy mud," and "mud"; the different sorts being determined when necessary by mechanical analyses. The paper contains details referring to the French coasts, but the work is even more needed in this country.

THE publication is announced of a new "Journal of American Science," under the name *Orcutt*. The *Journal of Botany* quotes the following paragraph from the prospectus:—"No complimentary copies; no free samples; no exchanges; no advertisements in the text; no premiums; no discount to agents; the whole income going to make it better and larger. Botany and horticultural science will receive the greatest attention in the first numbers; botanists are invited to publish new species in its pages."

THE Report from the Curator, Lieut.-Colonel King, of the Royal Botanic Garden, Calcutta, for the year 1896-97, is one of considerable disaster; both that garden and the Lloyd Botanic Garden at Darjeeling having suffered much from the drought of that year, following the drought of 1895-96. Notwithstanding this, much useful work has been done in the cultivation of economic plants, the investigation of the flora of British India, and the enrichment of the herbarium. A monograph has been published of the Indian species of bamboo, by Mr. J. Sykes Gamble.

THE following are among the papers and other publications which have come under our notice within the past few days:—"On the Magnetic Properties and Electrical Resistance of Iron as dependent upon Temperature," by Dr. David K. Morris. This paper was read before the Physical Society last May, and is published in the *Philosophical Magazine* for September. The general character of the work and results are described in NATURE of May 20 (p. 70).—Prof. George H. Barton has sent us a report, reprinted from the *Technology Quarterly* (June), upon his "Glacial Observations in the Umanak district, Greenland." Prof. Barton was a member of the Boston party on the sixth Peary Expedition to Greenland, and his report is the second which has been published upon scientific work accomplished during the expedition.—"A Method of determining Magnetic Hysteresis Loss in Straight Iron Strips," by Prof. J. A. Fleming, F.R.S., read before the Physical Society on June 11 (see p. 166), and reprinted from the *Philosophical Magazine* for September.—The seventh and eighth parts of vol. ii. of Prof. G. O. Sars' "Account of the Crustacea of Norway" have just been issued by the Bergen Museum. The Desmosomidæ and part of the family of Munnopsidæ are described and illustrated.

THE additions to the Zoological Society's Gardens during the past week include a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, presented by Mr. W. R. Routledge; a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. C. Hardy; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mrs. C. J. Anson; an Ivory Gull (*Pagophila eburnea*) from the Arctic Regions, presented by Mr. F. G. Jackson; a Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. H. du Domaine; a King Parrot (*Aprosmictus cyanopygius*) from Australia, presented by

Dr. G. Granville Bantock; a Ring-tailed Coati (*Nasua rufa*), a Kinkajou (*Cercoleptes caudivolvulus*) from South America, deposited; an Indian Civet (*Viverricula malaccensis*) from India, a Chilian Sea Eagle (*Geranoaëtus melanoleucus*) from South America, purchased; a Patagonian Cavy (*Dolichotis patachonica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE DISINTEGRATION OF COMETS.—If a comet is regarded as a swarm of meteorites, *à priori* considerations point to disintegration as its ultimate fate. Schiaparelli and Bredichin have familiarised astronomers with this fact, and the Great Comet of 1882, as well as Brooks' Comet of 1889, were visible examples of the way in which cometary members of the solar system break up in their old age. M. M. O. Callandreau has a short article in the *Bulletin Astronomique* (September) upon this disintegrating tendency, and also upon the relation of Jupiter to comets of short period. The two subjects are very closely related, for there is evidence that individual orbits in the groups of comets of short period in the neighbourhood of Jupiter have been produced by a process of separation. What M. Callandreau has done is to estimate, in a general manner, the influence the trajectory described by the head of a comet has upon disintegration, and to determine the extent of the sphere of stability at different points of the orbit both when the sun's attraction is considered alone, and when it is considered with the action of Jupiter. The subject is dealt with entirely from a dynamical point of view, no account being taken of the influence of thermal radiation from the sun or of the apparent force of repulsion exercised by the sun upon cometary material. A comet is considered as a spherical swarm of particles, and the density of the swarm is either taken as uniform or varying uniformly with distances from the centre. It appears that the elliptical form of an orbit favours disintegration. The following consequences follow from equations obtained by considering the sun's action alone: (1) When the distance of the nucleus remains constant, the extent of the sphere of stability increases with increase of velocity. (2) The relation of the radii of the spheres of stability at aphelion and perihelion is approximately equal to $\left(\frac{1-e'}{1+e'}\right)^{\frac{4}{3}}$, where e' is the eccentricity of the orbit. As to the combined influence of the sun and Jupiter, it appears that if a comet gets within the Jovian sphere of attraction, the radius of which is 0·3 the radius of the earth's orbit, the disintegrating power upon the comet when near aphelion is equivalent to that of the sun upon a comet when at a perihelion distance of 0·58.

FORECAST OF THE NOVEMBER METEOR SHOWER.—Mr. W. F. Denning continues, in the *Observatory*, an interesting paper upon "The Great Meteoric Shower of November," and predicts the probable character of the showers which will occur during the next six or seven years. His forecast for this year's display is as follows:—"In 1864 (two years before the max. of 1866), a grand display of meteors was witnessed from the deck of a ship off Malta on the morning of November 13, and meteors were conspicuously numerous on the same morning in America. We are therefore entitled to expect a pretty abundant display in 1897, and should it prove a return of the same group which supplied the meteors of 1864, it will probably return in the morning hours of November 14. But the earth will intersect a point of the meteoric orbit rather further in advance of the comet than it did in 1864, and so the exhibition of 1897 is not likely to equal the former, unless, indeed, the richer part of the stream has lengthened out in the interval of thirty-three years, which is quite possible. The really dense part of the system which furnished the brilliant European display of 1866 (max. Nov. 13, 13h. 10m.), and the equally imposing American shower of 1867 (max. Nov. 13, 22½h.), is not likely to be visible in England, as the earth will be centrally involved with it on the 14th at midday. In America something of it may possibly be seen just before sunrise on the 14th. The moon will be full on the morning of the 9th, and will therefore be gibbous on the 14th, rising at 7h. 55m. at Greenwich, and being visible in Gemini during the whole night afterwards. The prospects are therefore by no means good, but a close watch should be maintained on the mornings of the 14th, 15th, and 16th; for if the atmosphere be clear, meteors will sure to be frequent, and fine ones may appear every now and then."

THE RELATIONSHIP OF PHYSIOLOGY, PHARMACOLOGY, PATHOLOGY, AND PRACTICAL MEDICINE.[1]

THE desire for knowledge which is common to the lower animals and man, savage or civilised, and has induced members of this Congress to come from the ends of the earth in order to gain information, must have led primitive man from the earliest times to study the great problems of physiology, the nature of life, of growth, of reproduction, and of death, as well as to notice the connection of the latter with mechanical injuries, such as the wounds inflicted by clubs and spears or by the teeth and claws of wild beasts.

Next to the problems of physiology come those of pharmacology, by which I mean the poisonous or remedial action of various substances, mineral, vegetable, or animal. A knowledge of this subject is found even amongst the lowest savages, and is of the greatest use to them, for it enables them, on the one hand, to avoid eating things which may cause discomfort, pain, or death, and, on the other, to obtain food by poisoning waters and thus catching fish, or by poisoning their arrows to kill game which would otherwise escape. Closely associated with the knowledge of the poisonous is that of the curative powers of herbs, and it is possessed by animals as well as man, for cows avoid noxious plants, and dogs will every now and again eat grass apparently as medicine. Primitive peoples use various substances as remedies in disease, with more or less success, and one of the most extraordinary points in their practice is that they seem to some extent to have forestalled the newest researches on venins, anti-venins, and organotherapy, for in Africa the Bushmen are accustomed to drink the poison of venomous snakes as a prophylactic against their bite, and the Hausas prevent hydrophobia by killing the mad dog and making the man it has bitten eat its liver.

The occurrence of death from wounds or poison is intelligible even to a savage, but when illness and death occur independently of these, men naturally attribute them to invisible powers. Thus the Dyaks of Borneo ascribe sickness to wounds from invisible spears weilded by invisible spirits, and during an epidemic of disease in the Middle Ages the cry often arose that the wells had been poisoned. These crude ideas contain germs of truth, and when we look at Prof. Metschnikoff's drawings of a Daphnia attacked by a Monospora we seem to recognise the invisible darts of the Dyaks, while during an epidemic of typhoid fever we have often to acknowledge that our wells have been poisoned by bacilli.

It is impossible to trace the steps by which the crude ideas of savage peoples regarding physiology, pharmacology, and pathology have grown into definite sciences, nor even to indicate the most important landmarks, though we naturally think of the names of Alkmaon, Galen, and Harvey in physiology; of Nicander, Magendie, and Bernard in pharmacology; and of Morgagni, Virchow, and Pasteur in pathology. During this century these three sciences have developed with almost incredible rapidity, a complete knowledge of them is enough to tax severely the most retentive memory, and it is almost impossible for any individual to keep up with the advance of all three of them.

But just as the whole subject of astronomy became suddenly simplified by a change of standpoint at the very time when cycles and epi-cycles became most bewildering, so at the very time when these three sciences are becoming most complex and diverse they appear to be tending to unification and simplification. Pathology, for example, is now becoming to a great extent a branch of pharmacology, for while a few years ago its chief object was to discover, examine, and classify the microbes which give rise to disease, it is now striving rather to discover the nature and actions of the ferments and poisons which they form, and by which they are able to cause disease and death in the animals they attack. Pharmacological investigation instead of being confined to the alkaloids and other poisons formed by higher plants has now extended to those formed by microscopic plants or microbes, and thus comes to include a great part of pathology.

In the same way, though pharmacology is a branch of physiology, inasmuch as it deals with the phenomena of life as modified by drugs, yet physiology may, to a certain extent, be

[1] An address delivered at the Twelfth International Medical Congress at Moscow, on August 19, by Dr. T. Lauder Brunton, F.R.S.

regarded as a branch of pharmacology, because some of the latest researches regarding the processes of life have been made by pharmacological methods, using the products of animal life instead of vegetable poisons. Amongst the pioneers in this line I may mention my two masters, Kühne and Ludwig; the former of whom by his chemical investigations has enabled us to differentiate the various products of albuminous decomposition, whilst the latter, with his pupils Schmidt-Mühlheim and Wooldridge, discovered the poisonous action of albumoses and peptones, and of the juices of various tissues when injected directly into the blood.

Before the proteid constituents of our food can be absorbed they must be split up during digestion into albumoses and peptones; yet these researches show that the very substances which are necessary to repair waste and are indispensable for the continuance of life, prove fatal when introduced into the body in a wrong way, or too great quantity. But the products of the digestion of albumin do not normally enter the circulation as albumoses and peptones. During absorption they undergo changes of a synthetic nature in the walls of the intestine, and probably to a certain extent also in the liver, so that they again form harmless substances, and their poisonous properties are destroyed before they enter the general blood stream.

But how is it that the ferments which decompose albuminous food and form poisons from it in the intestine do not pass into the blood and kill the animal by digesting the tissues and forming poisons from them? Of course pepsin cannot do so as it only acts in an acid medium, but there is no such hindrance to the action of trypsin, and yet it does not destroy the tissues composing the body itself. In all probability the reason why digestive ferments do not digest the tissues is not that they are destroyed in the digestive canal, nor yet that they are not absorbed, but that they are altered from active enzymes into inert zymogens which can be stored up without risk, and can again liberate active enzymes when these are required to digest a subsequent meal. In this respect they may be compared to the knives used by wandering peoples to cut up their meat, and which are not thrown away after each meal, but are simply put into sheaths which cover their edges and deprive them for a time of their cutting power.

But it is not in the intestine only that enzymes are found, they are also poured into the blood by the pancreas and probably by the thyroid and other glands. As our acquaintance with the processes of cell life increases, it seems more and more likely that the tissue change on which functional activity depends is effected by enzymes, and the truer do the speculations of Van Helmont appear—that life is a process of fermentation.

There can be little doubt that if enzymes in a free state were to circulate through the body they would do much harm, and indeed we may regard this as well-nigh proved in regard to the enzyme of tetanus.

But their action is limited either by their conversion into zymogens or their localisation to the cells or tissues where their action is required. This is more readily seen in plants than in animals, and one of the best examples of it is that in germinating wheat.

In the ordinary state of the grain the diastatic ferment is kept apart from the starch by a small layer of cellulose, through which the diastase cannot pass, but during germination another ferment appears which has the power of dissolving cellulose, and by breaking down this dividing membrane it allows the diastatic ferment to act upon the starch, and renders it available for the needs of the growing plant.

Enzymes appear to differ amongst themselves nearly as much as do albumin, albumoses and peptones. Some are easily separated from the cells in which they exist, whilst others are so closely united to the protoplasm that their separate existence apart from it has been denied. The yeast plant, for example, yields an invert enzyme which can be extracted with comparative ease, but the enzyme which splits up sugar into alcohol and carbonic acid is so firmly attached to the protoplasm of the cell that it is only within the last few months that it has been isolated by Buchner by the application of enormous pressure. It is probable that the enzymes contained in the cells of animal tissues differ in like manner, and that by the use of similar methods we may obtain a number of enzymes with which we are at present unacquainted.

But it is not merely the products formed in the digestive canal, or in the organs of animals during life, nor even the alkaloids that are formed by the higher plants, that act as poisons. The processes of life are much the same in the lowest microbes as in animals, or in the higher plants, and these microbes, by forming ferments and poisons, give rise to disturbance of function or death in animals. When grown in suitable media outside the body they produce enzymes and poisons, albumoses and alkaloids, and many of them continue to do so after their introduction into the body.

One of the most curious points, both in the chemistry of the higher plants and of microbes, is that they tend to form at the same time a poison and its antidote. In Calabar bean, for example, we find there are two poisons—physostigmine and calabarine, the former tending to paralyse the spinal cord and the latter to stimulate it, so that each poison to a certain extent antagonises the other. The same condition is found even more markedly in jaborandi, of which the two alkaloids pilocarpine and jaborine antagonise one another's action so that, although pilocarpine generally greatly predominates, it might be possible to get a specimen of the leaf having no action at all although it contained a quantity of alkaloids.

When injected into animals the toxins formed by microbes and the venins of serpents cause the production of anti-toxins and anti-venins which neutralise their action apparently by chemical combination in somewhat the same way as an acid and alkali, each poisonous by itself, combine to form a comparatively inert salt. But the two components here, like an organic acid and a mineral base, are unequally affected by destructive agencies, and the anti-venin may be destroyed, so that the venin again regains its activity.

The conversion of zymogens into enzymes may be compared to the freeing of venins from their compounds, while the conversion of active venins into inert bodies by combination with anti-venins suggest that a similar process may occur in the case of active enzymes, by which they may be converted into inactive zymogens.

Perhaps the hypothesis I mentioned eight years ago to my pupil and friend, Mr. Hankin, that the germicidal power of organisms is proportional to their power to produce enzymes may not be altogether unfounded, and possibly we may discover also that immunity, natural or acquired, is nothing more than an extension to the cells of the tissues generally of a power which is constantly exercised during digestion by those of the intestine and liver.

This problem is one which pertains to all three sciences, and has a most important bearing on practical medicine.

Practical medicine, except when empirical, depends for its advance on physiology, pharmacology, and pathology. A knowledge of the physiology of digestion has led to the satisfactory treatment of dyspepsia by the administration of digestive enzymes, and pharmacological research has enabled us to treat diseases of the circulation with a success previously undreamt of, by teaching us not only how to use aright old remedies, such as digitalis, but also how to apply new ones, such as strophanthus and amyl nitrite, and even to manufacture others, such as nitroerythrol, which possess the special actions we desire, but are lacking in the drugs we already have. Indeed new remedies, which shall alter tissue change, lower temperature, relieve pain, and procure sleep, are now being made in such numbers that it is hard to keep count of them.

But amongst all the new gains of practical medicine none are so remarkable as those which we owe to pathology. Time would fail me to speak of the prevention and cure of zymotic diseases, but no less astonishing is the discovery that myxœdema depends on inactivity or absence of the thyroid gland, and can be cured by the administration of its extract, which seems to act as an enzyme on living tissues, so that the heavy, shapeless features of the patient resume their natural expression, and the sluggish mental processes become quickened. An exhaustive study of enzymes and their products appears to be the most promising way of advancing our knowledge both of the nature and treatment of disease. Probably more is to be hoped for from an investigation into the nature and properties of those enzymes which are intimately associated with the protoplasm of the cells in the various tissues and organs than even of those which are poured into the blood by glands having an internal secretion, such as the thyroid. For all organs, even those which like muscles and nerves are not glandular, have an action on the blood comparable to that of the yeast plant, which modifies the fluid in which it lives by the substances which it removes from or adds to it. It is to a knowledge of the processes which

occur in the protoplasm of the cells in the intestinal wall and liver, and of the enzymes by which these processes are in all probability carried out that we must look for an explanation of the conversion of the poisonous albumoses formed during digestion into innocuous albumins, and of dangerous enzymes into harmless zymogens.

Moreover, it seems to me that it is by researches into the nature and action of the enzymes not only of microbes, but in the various tissues of the body in higher animals, that we shall learn how the microbes, like the enzymes of the intestinal canal, produce poisonous albumoses, and how the tissues, like the cells of the intestinal walls or liver, convert them into harmless or even protective substances. In this way we may hope to obtain an explanation of toxins and anti-toxins, of pathogenesis and immunity, as well as of the nature of diseases unconnected with the presence of microbes, such as diabetes. Twenty-three years ago I attempted to obtain a glycolytic enzyme from muscle, in order to enable diabetic patients to utilise the sugar in their blood. My attempt was unsuccessful, but we may still hope that by other methods we may obtain from animal organs various enzymes, the administration of which may prove as useful in other diseases as the thyroid in myxœdema.

Practical medicine depends on physiology, pharmacology, and pathology, but all three are tending to become more and more subdivisions of the wider and all-embracing science of chemistry. It is to a chemist, Pasteur, that we owe the wonderful development of pathology within the last quarter of a century, and we may fairly regard his fellow-countryman, Lavoisier, as the founder of this science. Men from all countries, and especially from Germany, have aided its development; but it seems fitting that at this Congress, in acknowledging our obligations to this science, we should not omit to mention that at its head now stands a Russian, Mendeleef, whose marvellous prescience enabled him to predict the existence of elements which were then unknown and even to describe their properties more correctly than those who first verified his predictions by obtaining the substances themselves. When we consider that little more than a hundred years have elapsed since the time of Lavoisier, and contemplate the vast benefits which medicine and its allied sciences have derived from chemistry during this time, our hopes cannot be otherwise than great for the centuries to come.

THE BRITISH ASSOCIATION.

TORONTO, *August* 25.

THIS has not been a large, but it has been a very interesting and satisfactory meeting both from the scientific and the social point of view. Out of the 1362 persons present, an unusually large proportion were well-known representative men of science. The more prominent members of each section seem to be with us, and it has been frequently remarked during the meeting that in our sectional officers we have brought over an unusually strong team. We have a fair number of distinguished foreigners, and a considerable number of the members of the American Association: these foreign members include General Billings, Dr. Anton Dohrn of Naples, Profs. Minot, Newcomb, Osborn, Putnam, Ira Remsen, Runge (Hannover), and others. Many Canadians have also taken part in the proceedings, and it may be said that in all the sections the work has been influenced in its nature and direction by our place of meeting. Canadian surveys, geography and climate, the chemistry of the soil, the fisheries and the biology of the lakes, the plants, the timber from the engineering point of view, statistics and trade combinations all received attention; while Sections C (Geology) and H (Anthropology) may fairly be said to have been dominated by the local spirit. The president of C was a distinguished Canadian geologist, Dr. George Dawson, and although the preliminary arrangements had to be made in this case by correspondence, the work of the section was remarkably well organised, and an unusually large number of abstracts were printed. There were papers and demonstrations on the rocks of North America from the Laurentian to the Glacial deposits, and several expeditions of geological interest were organised under local leaders. The Anthropological Section had a succession of interesting papers —notably those of Miss Alice Fletcher—dealing with the folklore, customs, religion, &c., of the North American Indians. The work of these two sections appropriately culminated to-day in a joint discussion on "The First Traces of Man in North America," during which Prof. Putnam gave an account of the supposed remains from the Trenton gravels. Prof. Claypole spoke of the human relics in the Drift of Ohio, and Sir John Evans criticised the evidence adversely and showed the probability of error as to the occurrence of the specimens supposed to be from glacial deposits.

Amongst other notable papers which attracted public attention were Profs. Meslans, Moissan and Dewar's demonstration of the preparation and properties of fluorine, and Lord Kelvin's statement as to the fuel supply and air supply of the world.

There seemed to be comparatively few joint meetings of sections—perhaps because each section was so full of its own work. Besides the combined session of C and H, mentioned above, E and F met to hear Mr. F. C. Selous on the economic geography of Rhodesia, and sections C, I, and K joined in discussing the chemistry and structure of the cell *à propos* of Prof. Meldola's paper on the rationale of chemical synthesis, Prof. Green's paper on an alcohol-producing enzyme in yeast, Prof. Macallum's paper on the significance of intracellular structures, and some histo-chemical demonstrations by Profs. Boyce and Herdman on the presence of copper, and by Prof. Macallum on the distribution of iron, in tissue cells.

The custom seems increasing in most of the sections of having a certain number of short addresses, lecturettes, or demonstrations on subjects of novelty or current scientific interest given at fixed times, and usually illustrated by lantern slides. Amongst these at the present meeting may be mentioned:—Sir George Robertson on Kafiristan, Prof. Dixon on explosion flames, Prof. Osborn on American Tertiary mammals, Dr. Munro on the Glastonbury Lake Village, Prof. Herdman on the oyster question, Prof. Poulton on mimicry and natural selection, Prof. Haddon on the evolution of the cart and the Irish car, and Mr. Seward's address on fossil plants. Section K had also some interesting papers and discussions on hybridisation, including an account by Dr. W. Saunders, Director of the Dominion Experimental Farms, of some experiments in cross-fertilisation made with the practical object of producing improved forms of apple and other fruit trees which will stand the severe climate of the North-west Territories. As an outcome of our visits to the experimental farms, and of what we have heard of them, both in the sections and outside, an important resolution, forwarded from Section B (Chemistry), has passed the Committee of Recommendations and the General Committee, to the effect that "the Council be requested to consider the desirability of approaching the Government with the view of the establishment in Britain of experimental agricultural stations similar in character to those which are producing such satisfactory results in Canada."

It may also be stated that, as the result of the consideration given by Section D to the fauna of the lakes, it is expected that a biological station will shortly be established by the Government of Ontario. A deputation of zoologists with this object in view waited upon the Premier and other members of the Cabinet, and the proposition was very favourably received. A fuller account of this matter will be given in the report of the proceedings of Section D.

Several of the sections, recognising that we are meeting in a new country, the natural products of which are more or less unfamiliar to many of the members, organised afternoon and even whole-day excursions in the neighbourhood of Toronto, under the guidance of local leaders. In this way Section B visited the chemical works at Niagara, Section C the glacial deposits, while Sections D and K had several joint expeditions to localities of biological interest. The General Committee at its final meeting to-day passed the report of the Committee of Recommendations recommending grants to committees for scientific purposes amounting to 1350*l*., a much larger sum than has been voted for some years. One of the reasons of this increase is that the committee are extremely anxious to make some grants for the pursuit of local investigations, to be expended by the various committees which have been appointed for the purpose of study and research in Canada. These Canadian committees are appointed for the following objects: the establishment of a meteorological observatory on Mount Royal, the investigation of the pleistocene fauna and flora, the collection of geological photographs, the biology of the lakes of Ontario, the condition of the North-west tribes, the ethnographic survey of Canada, and the establishment of a biological station in the Gulf of St. Lawrence. The total amounts voted to Committees are shown on the next page.

A—*Mathematics and Physics.*

	£	s.	d.
*Foster, Prof. Carey.—Electrical Standards ...	75	0	0
*Symons, Mr. G. J.—Seismological Observations...	75	0	0
*Atkinson, Dr. E.—Abstracts of Physical Papers...	100	0	0
*Harley, Rev. R.—Calculation of Certain Integrals	20	0	0
*Shaw, Mr. W. N.—Electrolysis and Electro-chemistry	35	0	0
Callendar, Prof.—Meteorological Observatory at Montreal	50	0	0
B—*Chemistry.*			
*Roscoe, Sir H. E.—Wave-length Tables of the Spectra of the Elements	20	0	0
*Reynolds, Prof. J. Emerson.—Electrolysis Quantitative Analysis	12	0	0
*Thorpe, Dr. T. E.—Action of Light upon Dyed Colours	8	0	0
Evans, Sir J.—Promotion of Agriculture	5	0	0
C—*Geology.*			
*Hull, Prof. E.—Erratic Blocks	5	0	0
*Bonney, Prof. T. G.—Investigation of a Coral Reef	40	0	0
*Flower, Sir W. H.—Fauna of Singapore Caves (unexpended balance in hand, 40*l.*)	—		
*Geikie, Prof. J.—Photographs of Geological Interest	10	0	0
*Marr, Mr. J. E.—Life-zones in British Carboniferous Rocks (unexpended balance in hand) ...	—		
Dawkins, Prof. W. Boyd.—Remains of the Irish Elk in the Isle of Man (unexpended balance in hand)	—		
*Jamieson, Mr. T. F.—Age of Rocks near Moreseat	10	0	0
Dawson, Sir J. W.—Pleistocene Fauna and Flora in Canada	20	0	0
D—*Zoology.*			
*Herdman, Prof. W. A.—Table at the Zoological Station, Naples	100	0	0
*Bourne, Mr. G. C.—Table at the Biological Laboratory, Plymouth	20	0	0
*Flower, Sir W. H.—Index Generum et Specierum Animalium	100	0	0
Miall, Prof.—Biology of the Lakes of Ontario ...	75	0	0
*Herdman, Prof. W. A.—Healthy and Unhealthy Oysters	30	0	0
E—*Geography.*			
*Ravenstein, Mr. E. G.—Climatology of Tropical Africa	10	0	0
F—*Economic Science and Statistics.*			
Sidgwick, Prof. H.—State Monopolies in other Countries	15	0	0
Price, Mr. L. L.—Future Dealings in Raw Produce	10	0	0
G—*Mechanical Science.*			
*Preece, Mr. W. H.—Small Screw Gauge	20	0	0
H—*Anthropology.*			
*Tylor, Prof. E. B.—North-western Tribes of Canada	75	0	0
*Munro, Dr. R.—Lake Village at Glastonbury ...	37	10	0
*Brabrook, Mr. E. W.—Ethnographical Survey (and unexpended balance in hand)	25	0	0
*Evans, Mr. A. J.—Silchester Excavation	7	10	0
*Dawson, Dr. G. M.—Ethnological Survey of Canada	75	0	0
Turner, Sir W.—Anthropology and Natural History of Torres Strait	125	0	0
I—*Physiology.*			
Gaskell, Dr. W. H.—Investigation of Changes associated with the Functional Activity of Nerve Cells and their Peripheral Extensions	100	0	0
K—*Botany.*			
Farmer, Prof. J. B.—Fertilisation in Phæophyceæ	15	0	0
Corresponding Societies.			
*Meldola, Prof. R.—Preparation of Report ...	25	0	0
	£1350	0	0

* Reappointed.

The evening lectures given before the Association were much appreciated. The projection of Prof. Roberts-Austen's electrical furnace upon the screen was especially a source of much interest to the inhabitants of Toronto. The evening reception given by the Governor-General and Lady Aberdeen was a brilliant function. At the second conversazione, given by the Local Executive Committee, one missed the usual lantern lectures, demonstrations and exhibits; but it was a pleasant gathering marked by much cordiality between hosts and guests, and utilised by members for comparing notes as to the work of the sections, and as to plans for taking advantage of the numerous expeditions and visits to places of interest provided for their visitors by the Local Committee. Four parties start for the Pacific coast during the next few days, stopping at various points of scientific or industrial interest on the way, under the guidance of men of first-rate local knowledge such as Dr. George Dawson, Dr. W. Saunders, Mr. Walker, one of the Local Secretaries, and others. The end of this article is being written in the train as the first of these parties, including Lord Kelvin and Sir John Evans, is passing along the northern shores of Lake Superior. Other expeditions have been organised to the Muskoka Lakes, to Niagara, to Parry Sound, &c., in addition to visits to Montreal and Ottawa.

The arrangements of the Local Committee have been excellent, and it was felt at the concluding meeting, when cordial votes of thanks were passed to our hosts, to the Local Executive, and especially to Prof. Macallum and his colleagues the Local Secretaries and Treasurers, that much hard work had been done, and that our thanks were thoroughly deserved. The University of Toronto and Trinity University both conferred honorary degrees upon a few of their eminent guests, and a great banquet in honour of Lord Kelvin, Lord Lister and Sir John Evans, the three notable figures of the gathering, formed a fitting and enthusiastic termination to a memorable meeting.

W. A. HERDMAN.

SECTION K.

BOTANY.

OPENING ADDRESS[1] BY PROF. H. MARSHALL WARD, Sc.D., F.R.S., F.L.S., PRESIDENT OF THE SECTION.

THERE are many industrial processes which depend more or less for their success on bacterial fermentations. The subject is young, but the little that has been discovered makes it imperative that we should go on, for not only are the results of immense importance to science, but they open up vistas of practical application, which are already being taken advantage of in commerce, and we may be sure that every economic application of such knowledge will give the people employing it an advantage over those who proceed by the old rule-of-thumb methods, where nobody knows or cares where the waste or leakage occurs that spoils a commercial product.

The discovery by Alvarez of the bacillus which converts a sterilised decoction of indigo plant into indigo sugar and indigo white, the latter then oxidising to form the valuable blue dye, whereas the sterile decoction itself, even in presence of oxygen, forms no indigo, may be cited as a case in point. It remains to be decided whether this bacillus alone is concerned, or whether the infusion of indican will ferment under the action of enzymes alone derived from the leaves of the indigo plant. It also remains for future investigation to determine whether the indigo bacillus is the same as the pneumonia bacillus—which resembles it—and will also induce the indigo fermentation, and to explain why the woad-makers of the Fens find a sale for this indigo preparation among indigo makers, as well as to clear up certain mysterious "diseases" in the indigo-vats. Our much more extensive knowledge of the diseases of beer and wine suggests the possibility of profitable bacteriological investigations in several directions here.

That certain stages in the preparation of tobacco-leaves—as also in the preparation of tea—depend on a carefully regulated fermentation, which must be stopped at the right moment, or the product is impaired, or even ruined, has long been known. Regarding the possible *rôle* of bacteria in the preparation of tea, nothing is ascertained, but, if Suchsland's investigations are confirmed, there is among the many and various organisms concerned in the fermentation of West Indian tobacco a bacterium which has been isolated and plays an important part. It is

[1] Concluded from p. 461.

claimed that the flavour of European-grown tobacco can be materially improved by its use. I read that the process is patented, which may or may not affect its value as a scientific announcement; but in view of the increasing number of researches into this subject by Behrens, Dávalos, Schloesing, and others, it is evidently a domain for further bacteriological investigations in a properly equipped laboratory.

Every botanist knows that flax and hemp are the bast fibres of *Linum* and *Cannabis* respectively, separated by steeping in water until the middle lamella is destroyed and the fibres isolated: but it is perhaps not so well known that not every water is suitable for this "retting" or steeping process, and for a long time this was as much a mystery as why some waters are better than others for brewing.

Only quite recently Fribes, working under Winogradsky, has isolated the bacillus which accomplishes this dissolution of the middle lamella, and its behaviour brings to light some very interesting details, and furnishes another of those cases where the reactions of living micro-organisms can be utilised in deciding questions of plant chemistry too subtle for testing with ordinary reagents.

You are aware that recent researches, especially those of Maquin in France and of Walter Gardiner in Cambridge, Cross and Bevan and others, have caused us to discard the view that the middle lamella is composed of cellulose, and to learn that it consists of pectin compounds. Now Fribes' anaërobic bacillus dissolves and destroys pectins and pectinates, but does not touch cellulose or gum, and thus enables us to criticise from a new point of view the bacillus (*B. Amylobacter*) which Van Tieghem asserted to be the cause of cellulose fermentation and the retting of flax. Clearly it cannot be both, otherwise the flax-fibre would be destroyed; and we know from other facts that *B. Amylobacter* is not the cellulose ferment.

Fribes' discovery has yet to be tested with reference to other processes of retting. The Indian Government have lately published a series of notes on jute and other fibres, and the description of the retting of jute suggests this as a very definite problem for investigation.

I am told that a patent exists in the United States for a process whereby the retting organisms may be sown and encouraged in waters otherwise unfitted for the steeping of flax, &c., another indication of the keen interest taken in these matters.

It goes without saying that the steeping of skins in water in preparation for tanning involves bacterial actions, owing to which the hair and epidermal coverings are removed; but it appears from recent investigations that in the process of swelling the limed skins, the gases evolved in the substance of the tissues, and the evolution of which causes the swelling and loosens the fibre so that the tanning solutions may penetrate, are due to a particular fermentation, caused by a bacterium which, according to Wood and Wilcox, is similar to, if not identical with, a lactic ferment. If Haenlein's results may be accepted, it is a bacillus introduced into the tanning solution by the pine bark, which is responsible for the advantageous acidification of the tanning solutions much valued for making certain kinds of leather, and of decisive importance in the quality, so that tanners add the souring liqour of other vats to encourage the souring of the doubtful one.

Hay is made in very different ways in different countries, and in those where a "spontaneous" heating process is resorted to there seems to be no doubt that certain thermogenic bacteria are concerned. The researches of Böhmer, Dietrich, Fry, Lafar, and others show that here and in the preparation of ensilage we have important fermentation processes which affect the end result.

The whole question of fermentation in hay, and the high temperatures produced in the process, as well as what occurs in straw-stacks under similar conditions, have important theoretical bearings, and we know of bacilli which grow at 70° C.

Probably no other subject in this domain has, however, attained so much importance as the bacteriology of the dairy—the study of the bacteria found in milk, butter, and cheese in their various forms. In all cases of this kind, as in brewing, bread-making, and so on, there are three aspects of the bacteriology of the operations: we have to consider first the bacteria concerned in the normal process; secondly, introduced forms which bring about abnormalities, or "diseases" of the normal operation; and, thirdly, the possible pathogenic bacteria, *i.e.* pathogenic to man, which may lurk in the product.

Of milk especially much has been said as a disease-transmitting medium, and with good reason, as is well known; and if we may accept the statement of a continental authority, who calculated that each time we eat a slice of bread and butter we devour a number of bacteria equal to the population of Europe, we have grounds for demanding information as to what these bacteria are, and what they are doing. And similarly with cheese, every kind of which teems with millions of these minute organisms.

Now I cannot, of course, go into the question of pathogenic bacteria, nor is there time to discuss those forms which bring about undesirable or abnormal processes in the dairy; but I want to call your attention to the splendid field for bacteriological investigation which is being opened up by inquiries into the normal changes utilised in making butter and cheese.

We may pass over the old controversies as to the souring of milk, culminating in Pasteur's discovery of the bacteria of lactic fermentation in 1857-58. Lister in 1877 isolated *Bacterium lactis*. Hueppe in 1884 confirmed his results, and added several other lactic bacteria, and we now know a whole series of forms which can turn milk sour by fermenting its sugar, and this in various ways, as Warington and others have shown. The souring of milk and cream by merely leaving it to stand often led to failure, and the study of this preliminary to butter- and cheese-making is itself a bacteriological question of great importance. We shall not be surprised, therefore, that when, in 1890, Wiegmann proposed to use pure cultures of lactic-acid bacteria for the souring of cream, the plan was at once taken up.

Some years ago Storch found that the peculiar aroma of a good butter was due to a bacterium which he isolated, and Wiegmann has now two forms, or races, one of which develops an exquisite flavour and aroma, but the butter keeps badly, while the other develops less aroma, while the butter keeps better.

According to a recent publication of Conn's, however, this subject has been advanced considerably in America, for they have isolated and distributed to numerous dairies pure cultures of a particular butter-bacillus which develops the famous "June flavour" hitherto only met with in the butter of certain districts during a short season of the year. I am told that this fine-flavoured butter is now prepared constantly in a hundred or more American dairies. Simultaneously with these advances in the manufacture of pure butter with constant flavour, the days of "diseased" butters seem numbered.

Properly considered, the manufacture of cheese is a form of microscopic gardening even more complex and more horticultural in nature than the brewing of beer. From the outset, when the cheesemaker guards and cools his milk till his stock is ready, he is doing all he knows how to do to keep down the growth of the germs introduced into the milk; he then coagulates it, usually with rennet—an enzyme of animals, but also common in plants—and the curd thus prepared is simply treated as a medium on which he grows certain fungi and bacteria, with the needful precautions for favouring their development, protecting them against the inroads of animal and plant pests, and against unsuitable temperature, moisture, access of light, and so on. Having succeeded in growing the right plants on his curd, his art then demands that he shall stop their growth at the critical period, and his cheese is ready for market.

The investigations of Duclaux, Wiegmann, and others on the continent, of Conn in America, and of Lloyd in England, to say nothing of other workers now busy at this subject in various parts of the world, are getting at the particular forms of fungi concerned in so altering the constitution of curd that it becomes the very different article of food we call cheese, and they have even determined to some extent what *rôle* is played by these plants in giving the peculiar odours and flavours to such different cheeses as Camembert, Stilton, and Roquefort. It is known, for instance, that a certain fungus (*Penicillium*) cultivated on bread is purposely added to Roquefort, and that it destroys the lactic and other acids, and so enables certain bacteria in the cheese, hitherto inhibited in their actions by these acids, to set to work and further change the medium, whereas in making Emmenthaler cheese the object is to prevent this fungus thus paving the way for these bacteria. Pammel claims to have discovered a bacillus which gives a peculiar and much-admired clover aroma to certain cheeses, and according to recent statements a definite *Streptococcus* is responsible for the peculiarities of certain Dutch cheeses, and so on. Nevertheless, we are still profoundly ignorant of most of the forms concerned in the ripening of cheese, and every research which throws light on this difficult and complex subject, and so paves the way to

rendering uniform and certain this at present most haphazard and risky manufacture will be doing service to the State. Considering that Cohn only discovered that the ripening process is due to bacteria in 1875, and that Duclaux only published his researches on *Tyrothrix* in 1878, we can scarcely be surprised that the interval has not been long enough for the isolation and study of the numerous and curious forms, several hundreds of which are now imperfectly known. Nevertheless, there are signs of advance in various directions, and researches into the mysteries of Roquefort, Gorgonzola, Emmenthaler, and other cheeses are being industriously pursued on the continent. Even as I write this comes the news that Freudenreich has discovered the coccus which causes the ripening of Emmenthaler cheese. It is not impossible that the much more definite results obtained by investigations into the manufacture of the vegetable cheeses of China and Japan will aid bacteriologists in their extremely complex task.

These vegetable cheeses are made by exposing the beans of the leguminous plant *Glycine*—termed soja-beans—to bacterial fermentations in warm cellars, either after preliminary decomposition by certain mould-fungi, or without this. The processes vary considerably, and several different kinds of bean-cheeses are made, and known by special names. They all depend on the peculiar decompositions of the tissues of the cotyledons of the soja-bean, which contain 35 to 40 per cent. of proteids and large quantities of fats. The softened beans are first rendered mouldy, and the interpenetrating hyphæ render the contents accessible to certain bacteria, which peptonise and otherwise alter them.

Here, however, I must bring this subject to a close, and time will not permit of more than the mere mention of the vinegar fermentation, to which Mr. Adrian Brown has lately contributed valuable knowledge, of the preparation of soy, a brine extract of mouldy and fermented soja-beans, of bread-making, and other equally interesting cases.

When the idea of parasitism was once rendered definite, as it was by De Bary's work, and the fundamental distinction between a parasite and a saprophyte had been made clear, it soon became evident that some distinction must be made between *obligate facultative parasites* and *saprophytes* respectively; but when De Bary proposed the adoption of these terms of Van Tieghem's he can hardly have contemplated that they would be abused as they have been, and was clearly alive to the existence of transitions which we now know to be so numerous and so gradual in character that we can no longer define any such physiological groups.

Twenty years ago *Penicillium* and *Mucor* would have been regarded as saprophytes of the most obligate type, but we now know that under certain circumstances these fungi can become parasites; and the border-land between facultative parasites and saprophytes on the one hand, and between the former and true parasites on the other, can no longer be recognised.

In 1866 the germ of an idea was sown which has taken deep root and extended very widely. De Bary pointed out that in the case of lichens we have either a fungus parasite on an alga, or certain organisms hitherto accepted as algæ are merely incomplete forms. In 1868 Schwedendener declared the lichen to be a compound organism.

In 1879, in his celebrated lecture, De Bary definitely launched the new hypothesis, and brought together the facts which warranted his disturbance of the serenity of those unprepared to accept so startling a new notion as *Symbiosis*.

The word itself, in the form "Symbiotismus," is due to Frank, who, in an admirable paper on the biology of the thallus of certain lichens, very clearly set forth the existence of various stages of life in common.

This paper has been too much overlooked; but its existence is the more noteworthy from its being in the same number of the "Beiträge zur Biologie"—which we owe to Cohn, the founder of scientific bacteriology—in which Koch's remarkable paper on Anthrax occurs.

The details of these matters are now principally of historical interest; we now know that lichens are dual organisms, composed of various algæ, symbiotic with ascomycetes and even basidiomycetes, and, as Massee has shown, even gastromycetes. The soil contains also bacterio-lichens. The point for our consideration is rather that botanists were now awakened to a new biological idea—viz. that a fungus may be in such nicely balanced relationships with the host from which it derives its supplies as to afford some advantage in return, whence we must look upon the limited liability company formed by the two symbionts as a better business concern than either of the plants could establish for itself—a case, in fact, where union is strength. Symbiosis, consequently, is now understood to be of advantage to both the symbionts, and not to one only, as is the case in parasitism, or, to use Vuillemin's term, *Antibiosis*.

In 1841 an English botanist, Edwin Lees, discovered the existence of "a hirsuture that appears like a byssoid fungus" on the roots of *Monotropa*, and observed that the hyphæ linked the roots to those of a beech; he regarded the fungus as conveying nutriment from the latter to the former, and as an essential constituent of the *Monotropa*. This discovery was published in the now defunct "Phytologist" for December 1841, and was unearthed by Oliver and by Dr. Dyer, of Kew. This is apparently the first observation of a mycorhiza yet recorded, and, although the naturalists referred to did not understand the full significance of Lees' find, several of them made excellent guesses as to the meaning of the phenomenon. As Dr. Dyer points out, it disposes of Wahrlich's claim that Schleiden (1842) first discovered mycorhiza, as well as of Woronin's contention that the priority is due to Kamienski, though the latter (1881–82) probably was the first to clearly indicate that we have here a case of symbiosis, and thus anticipated Frank's generalisation in 1885.

Kamienski and Frank, followed by numerous other observers, among whom Oliver and Groom are to be mentioned, have now shown that the peculiar type of symbiosis expressed in this intimate union of fungus-hyphæ with the living cells of the roots of trees and other plants in soils which abound in vegetable remains—*e.g.* leaf-mould, moors, &c.—is very common.

In the humus of forests we find the roots of beeches and other *Cupuliferæ*, willows, pines, and so forth, clothed with a dense mantle of hyphæ and swollen into coral-like masses of mycorhiza; in similar soils, and in moorlands which abound in the slowly decomposing root-fibres and other vegetable remains so characteristic of these soils, the roots of orchids, heaths, gentians, &c., are similarly provided with fungi, the hyphæ of which penetrate further into the tissues, and even send haustoria into the living cells, but without injuring them.

As observations multiplied it became clear that the mycorhiza, or fungus-root, was not to be dismissed as a mere case of roots affected by parasites, but that a symbiotic union, comparable to that of the lichens, exists; and that we must assume that both the tree and the fungus derive some benefit from the connection.

Pfeffer, in 1877, suggested that the deficiency of root-hairs observed in orchids might be explained by the fungus-hyphæ playing the part of these organs, and taking up materials from the soil which they then handed on to the roots. He is quite clear on the subject, and recognises the symbiosis definitely, comparing it with other cases of symbiosis indicated by De Bary.

Frank stated that, as the results of experiments, seedling forest-trees cannot be grown in sterilised soil, where their roots are prevented from forming mycorhiza, and concluded that the fungus conveys to the roots organic materials, which it obtains by breaking down the leaf-mould and decaying plant-remains, together with water and minerals from the soil, and plays especially the part of a nitrogen-catching apparatus. In return for this important service the root pays a tax to the fungus by sparing it certain of its tissue contents, and no doubt can well afford to do so.

It appears that the mycorhiza is only formed where humus or vegetable-mould abounds. In sandy soils the roots bear root-hairs, as usual, and it is now clear that, while mycorhiza is a far more general phenomenon than was previously supposed, it is not essential for all the roots, nor even under all circumstances for any of them.

Probably what really happens is this. Trees and other plants with normal roots and root-hairs, when growing in ordinary soil, can adapt their roots to life in a soil heavily charged with humus only by contracting the symbiotic association with the fungus and paying the tax demanded by the latter in return for its supplies and services. If this adaptation is impossible, and no other suitable variation is evolved, such trees cannot grow in such soils.

In certain cases—*e.g.* ground orchids, *Monotropa*, various *Ericaceæ*, &c.—it would seem that the plant is unable to grow in other than humus soils, and always forms mycorhiza.

Much further we cannot at present go, but it is evident that various different grades of symbiosis exist in these mycorhizas.

In the first place, there are several different fungi concerned—those on cupuliferæ and pines, apparently mostly *Tuberaceæ* and *Gasteromycetes*, and allied forms, being different from those in orchids, some at least of which appear to be *Nectrias* or related genera.

The physiological relations of the root to the fungus must be different in details in the case of non-green, purely saprophytic plants, like *Neottia*, *Monotropa*, &c., and in that of the green plants like *Erica*, *Fagus*, *Pinus*, &c.

It is well known that ordinary green plants cannot utilise vegetable débris directly, whereas trees in forests appear to do so; this in appearance only, however, for the fungi, yeasts, and bacteria there abounding are actively decomposing the leaves and other remains.

Now it is possible that the mycorhiza theory is not applicable in all cases, and that, sometimes, what happens is this. The trees, once well established, make so good a fight that in spite of the leaf-decomposing fungi attacking their roots parasitically, or merely ensconcing themselves in the dead primary cortex as it is sloughed, they manage to keep going and to obtain such shares of the nitrates and other products due to the fungus-action as satisfy their needs. But although there may be something to be said for this view as regards a few forest-trees, it is not easy to see how it would apply to the non-assimilating humus-plants like *Neottia*, *Monotropa*, &c., and we may probably regard the two sets of cases as standing or falling together.

No treatment of this subject would be complete without reference to those obscure cases of symbiosis—as we must regard them—between certain algæ which occur in the cavities of the leaves of *Azolla* and in *Gunnera*, and those found in the intercellular spaces of cycad-roots. When we know more of the physiology of these blue-green algæ, it may be possible to explain these puzzles, but at present they are mysterious curiosities.

A class of pseudo-symbiotic organisms is being more and more brought into the foreground where the combined action of two symbionts results in death or injury to a third plant, whereas each symbiont alone is harmless, or comparatively so.

Some time ago Vuillemin showed that a disease in olives results from the invasion of a bacillus (*B. oleæ*), which, however, can only obtain its way in the tissues through the passages driven by the hyphæ of a fungus (*Chætophoma*). The resulting injury is a sort of burr. Vuillemin has this year observed the same bacillus and fungus in the canker burrs of the ash, and so confirms Noack's statement to the same effect

Among many similar cases, well worth further attention, the invasion of potato-tubers by bacteria, which make their way down the decaying hyphæ of pioneer fungi, may be noted. I have also seen tomatoes infected by these means, and have facts showing that many bacteria which quicken the rotting of wood are thus led into the tissues by fungi.

Probably no subject in the whole domain of cryptogamic botany has wider bearings on agricultural science than the study of the flora and changes on and in manure and soil.

As vegetable physiology and agricultural science progressed, it became more and more of primary importance that we should learn what manure is composed of, what changes it undergoes in the soil, and what the roots of plants do with it. Chemistry did much to solve some of the earlier problems, but it soon became evident that it only raised new questions which it could not solve; and it was not till the sequence of changes induced by the successive growths of *Mucor*, *Pilobolus*, *Coprinus*, *Ascobolus*, and other moulds and fungi of various sorts, followed by bacteria and yeasts, began to be understood, that anything approaching a coherent account of the complex phenomena going on in soil or in a manure-heap could be attempted. Not that all the difficulties have been solved even now, but we are at least able to trace some very important chains of occurrences which throw light on many hitherto obscure matters going on in the field.

Since Pasteur in 1862, and Van Tieghem in 1864, showed that certain bacteria are concerned in converting urea to ammonium carbonate, much has been learnt, and we now know from the investigations of Miquel, Jaksch, Leube, and others that numerous urea-bacteria exist; and Miquel, in 1890, isolated an extremely unstable enzyme—urase—which converts sterile urea to ammonium carbonate very rapidly, a discovery of considerable interest, as it was one of the first examples of this class of bodies to be examined; and when we reflect on the enormous quantities of urea which have to be destroyed daily, and that fresh urine is in effect a poison to the roots of higher plant, some idea of the importance of these urea-bacteria is obtained. The necessity for preventing the losses of this volatile ammonia by fixing it in the soil and presenting it to the action of the nitrifying organisms is also obvious.

Winogradsky's classical isolation and cultivation of bacteria which take up these ammonia compounds and oxidise them to nitrous and to nitric acids in the soil, may be quoted as further instances of the bearing of bacteriological work on this department of science, as explaining not only the origin of nitre-beds and deposits, but also the way the ammonia compounds fixed by the soil in the neighbourhood of the root-hairs are nitrified and so rendered directly available to plants.

The theoretical explanation of many questions connected with the washing out of nitrates from fallows, the advantages of autumn and winter sowing, and processes occurring in the upper soil as contrasted with sub-soil, has been rendered much easier by these researches; moreover, as is now well known, they brought to our knowledge a startling instance of the assimilation of carbon-dioxide by these non-green plants—bacteria—which not only take some of the purely inorganic ammonia, but by means of energy set free by its oxidation obtain their carbon also by breaking up the carbonate—a true case of the assimilation of carbon-dioxide by a plant devoid of chlorophyll and without the direct aid of light. Indirectly, it is true, the source of the energy is the light of the sun, because the oxygen employed by these aërobic forms has been liberated by green plants in the last instance; but the case is none the less a startling and important contribution to physiology, and Winogradsky's work, which had been preceded by investigations in England by Warington and others, affords one of the best illustrations I know of the importance of this branch of botanical investigation.

Stutzer and Hartleb's recent publications go to show that the nitrifying organism is a much more highly developed and complex form than has hitherto been suspected; that it can be grown on various media, and exhibits considerable polymorphism—for instance, it can be made to branch, and show the characteristics of a true fungus, statements confirmed to a certain extent and independently by the even more recent work of Rullmann; and it appears that we have much more to learn of the morphology of this widely-spread and interesting plant.

It is impossible to go into the controversy between the observers referred to and Winogradsky, the discoverer of the definite nitrifying organism; but there is one point I must just mention: if Stutzer and Hartleb's details are confirmed we have here the most remarkable case of polymorphism I know of, for they claim characters for their fungus which prevent our putting it into any existing group.

I have for some time insisted on the fact that river-water contains reduced forms of bacteria—*i.e.* forms so starved and so altered by exposure to light, changes of temperature, and the low nutritive value of the river-water, that it is only after prolonged culture in richer food-media under constant conditions that their true nature becomes apparent. Now, Stutzer and Hartleb show that the morphological form of the nitrifying organism can be profoundly altered by just such variations in the conditions as the above, and occurs as a branched mycelial form, as bacilli or bacteria, or as cocci of various dimensions according to conditions.

These observations, and the researches of Zopf, Klebs, and others on variations in form (polymorphism) in other fungi and bacteria, open out a vast field for further work, and must lead to advancements in our knowledge of these puzzling organisms; they also help us to explain many inconsistences in the existing systems of classification of the so-called "species" of bacteria as determined by test-tube cultures.

But the urea bacteria and the nitrifying organisms are by no means the only forms found in manure and soils.

In 1868 Reiset found evidence of a reduction of nitrates in fermenting beet-juices, and in 1873 Schloesing found that free nitrogen escaped in certain soil-fermentations. Further work by Mensel, Deherain, and others led to the suspicion that certain bacteria can undo the work of the nitrifying organisms, and in 1879 Warington showed that both nitrites and nitrates occurred in his soil-fermentations.

In 1886 Gayon and Dupetit put this almost beyond doubt, and in 1891 Giltay and Aberson isolated and cultivated a denitrifying bacterium, capable of completely reducing nitrates with evolution of free nitrogen, provided it is cultivated anaërobically.

Several such forms have now been obtained, the observations of Burri and Stutzer that certain of the commonest bacteria of the alimentary canal— e.g. *B. coli commune*—abounding in fresh manure, are especially active, being particularly suggestive. You will thus notice that we have now a sketch of the whole of the down-grade part of the cycle of organic nitrogen in nature; it only needs supplementing by the history of the fixation of free nitrogen from the atmosphere by leguminous plants and certain soil-organisms to complete the sketch.

As is well known from investigations in which Eriksson, Woronin, Frank, Prazmowski, and others, including myself, have taken part, the nodules on the roots of leguminous plants contain a fungus—the morphological nature of which is in dispute—living in symbiotic union with the protoplasm of the cells. Hellriegel and Wilfarth showed in 1888-90 that, provided the root-nodules are present, these leguminous plants fix the free nitrogen of the atmosphere; and Laurent and Schloesing put this beyond all doubt in 1892 by demonstrating that a closed atmosphere in which *Leguminosæ* grow loses nitrogen in proportion as the plants gain it. Meanwhile Schulz Lupitz had shown that agricultural land poor in nitrogen can be made to accumulate it in paying quantities by growing lupines on it, and quite recently pure cultures of the organism of the nodules have been placed on the market under the unfortunate name *Nitragin*. It is claimed that these organisms can be readily used in practice to inoculate the seeds or soil.

Kossowitsch in 1894 showed that certain symbiotic unions of algæ with bacteria are also capable of fixing nitrogen; and Winogradsky declares that there exists in the soil a bacterium which, provided it is kept protected from oxygen by aërobic soil organisms, can itself do this. We are quite unaware of the mechanisms here concerned; but in all cases it appears certain that active destruction of carbohydrates is an essential condition, and we can only assume that the nitrogen is forced into synthetic union by means of energy derived from this destruction. Here, then, we have a glimpse of the up-grade part of the cycle of nitrogen in nature, the importance of which to agriculture cannot be overrated. As to the theoretical bearings of the matter, we are still much in the dark, and can only anxiously await the results of further investigations into the nature of the peculiar fermentations and their products going on in these nodules. I now want to draw your attention to a bearing of the above discoveries concerning denitrifying bacteria on some agricultural and horticultural questions.

It is well known that a gardener eschews the use of fresh manure. Why is this? The most obvious reply might seem to be, because the ammonia compounds and other nitrogenous constituents in such manure are not directly useful, or are even harmful to the roots of the plants. Some recent researches suggest that the matter is more complex than this.

It has not unfrequently happened that a farmer, finding himself short of stable-manure, has made up the deficit by adding some such artificial manure as Chili saltpetre, his argument running somewhat as follows:—Both are good nitrogenous manures, the one acting slowly, the other rapidly, so that a mixture of both should be better than either alone. The results have disappointed him, and numerous experiments in Norfolk, as I am informed by Mr. Wood, and in the North of England, as Dr. Somerville assures me, have shown that most disastrous results ensue if such mixtures are used, whereas if the farmyard manure is employed at first—the "shorter" the better—and the nitrates applied later on as a "top-dressing," excellent crops follow. The explanation seems to come from some recent experiments by Wagner, Maercker, Burri and Stutzer, and others. The farmyard manure, especially if fresh, so abounds in denitrifying bacteria that they destroy the nitrates rapidly and completely, free nitrogen escaping. Curiously enough, a very active denitrifying bacillus was found on straw, and we know that straw abounds in such manures.

I did not intend to go so far into agricultural details as this, but it was impossible to resist these illustrations of the splendid field of mycological research which here lies before us.

Nor can I avoid instancing at least one more example of the organisms at work in manure. We all know what enormous quantities of cellulose are manufactured daily, and even hourly, by the activity of green leaves; and when we reflect on the millions of tons of dead-wood, straw, fallen leaves, roots, &c., which would accumulate every year if not destroyed, we see at once how important is the scavenging action of the moulds and bacteria which gradually reduce these to carbon-dioxide and water, setting these gases free to enter once more into the cycle of carbon, oxygen, and hydrogen in nature.

In 1890 Van Senus obtained two bacteria, one an aërobic and the other an anaërobic form, which in symbiotic union were found to excrete an enzyme which dissolved cellulose. Such a cellulose-dissolving enzyme I had myself isolated from the *Botrytis* of the lily disease in 1888. In 1895 Omeliansky, working with river mud, found an anaërobic bacillus which dissolves paper with remarkable rapidity. I can only hint at the importance of these forms in connection with the production of marsh gas in swamps, the question of the digestion of cellulose in herbivorous animals, the manufacture of ensilage, and the processes of "shortening" of manure; and it is clear they have much to do with the destruction of paper, &c., in sewers and refuse-pits. Moreover, their further investigation promises a rich harvest of results in explanation of the rotting of stored tubers, certain diseases of plants, and several theoretical questions concerning anaërobism, butyric fermentation, and, possibly, that extremely difficult question on which Mr. Gardiner has done such excellent work, the nature of the various celluloses and constituents of the cell-wall.

I now turn to the subject of fungus epidemics, of world-wide interest, if only because the annual losses to agriculture due to epidemic diseases of plants amount to millions of pounds sterling.

The history of wheat-rust can be traced to Genesis, and at least five references to it exist in the Old Testament. The Greeks were familiar with it, and the Romans had a special deity and special ceremonies devoted to it. References can be given to it in old Norman times, and Shakespeare can be quoted as acquainted with it.

According to Loverdo, a law existed in Rouen in 1660, authorising the pulling up of barberry bushes as in some mysterious way connected with rust, and in 1755 the celebrated Massachusetts law was promulgated. Eriksson refers to an English farmer destroying his neighbour's barberry in 1720.

The words *Robigo*, *Rubigo*, *Rouille*, *Ruggine*, *Rufus*, and *Rust* comprise a history in themselves, into which, however, we have not time to go, and there are many fascinating points in the history of wheat-rust which must be passed over.

Felice Fontana in 1767 probably made the first scientific investigation of rust; he distinguished the uredo- and puccinia-stages under other names, and even thought of them as rootless plants exhausting the wheat; in this, and his conviction that no remedy was possible until a careful study of all phases of the disease had been made, he was far ahead of his times.

Jethro Tull, Marshall, and Withering are the most conspicuous English names in connection with this question and period, and Marshall in 1781-84 experimented intelligently with barberry and wheat inter-planted.

Persoon in 1797 gave the name *Puccinia graminis* to the fungus. In 1805 Sir Joseph Banks described it, and suggested that the germs entered the stomata: he also warned farmers against the use of rusted litter, and made important experiments on the sowing of rusted wheat-grains.

A great discussion on the barberry question followed, in which Banks, De Candolle, Windt, Fries, and others took part, Fries particularly insisting on the difference between *Æcidium berberidis*—a name conferred by Gmelin in 1791—and *Puccinia graminis*.

De Candolle had also distinguished *Uredo rubigo-vera* in 1815, and Schmidt soon after described a third wheat-rust—*Uredo glumarum*.

Matters were at about this stage when Tulasne confirmed the statement of Henslow—one of my predecessors in Cambridge—that the uredo- and puccinia-stages really belong to the same fungus, and are not, as Unger asserted, mixed species.

Then came De Bary and his classical investigation of the whole question in 1860-64. He proved that the *sporidia* of some Uredineæ (e.g. *Coleosporium*) will not infect the plant which bears the spores, and that the æcidia of certain other forms are only stages in the life-history of species of *Uromyces* and *Puccinia*.

In 1864 De Bary attacked the question of wheat-rust, and by means of numerous sowings of the teleutospores on barberry proved beyond doubt that they bring about its infection.

But De Bary did more. For the first time in history he saw the entrance of the infecting tube and the beginning of its growth in the tissues. In 1865 he demonstrated in the same faultless way the infection of the cereal by means of the æcidio-

spores, and showed that *P. rubigo-vera* alternates on Boragineæ as *Æc. asperifolii*, while *P. coronata*, separated by Corda in 1837, does the same as *Æc. Rhamni* on *Rhamnus*.

Thus was discovered the astounding phenomenon of *Heterœcism*, introducing a new idea into science and clearing up mysteries right and left.

During the next twenty-five years the number of heterœcious forms has risen to about seventy, including Woronin's recent discovery of this phenomenon in an ascomycete—*Sclerotinia heterœcia*.

About 1890 the rust question entered on a new phase. In Australia, India, Sweden, Germany, and America especially, active commissions, inquiries, and experiments were set on foot, and amid some confusion of meaning among some of those concerned much knowledge has resulted from the investigations of Plowright and Soppitt in England; Barclay in India; Cobb, Anderson, and McAlpine in Australia; Arthur, Bolley, Smith Ellis, Galloway, Farlow, Harper, and others in the United States; Dietel, Klebahn, Sorauer, and others in Germany; Rostrup in Denmark; and especially from the continued and indefatigable researches of Eriksson and Henning in Sweden. This renewed work has resulted in the complete confirmation of De Bary's results, but with the further discovery that our four common cereals are attacked by no less than ten different forms of rust belonging to five separate species or "form-species," and with several physiological varieties, and capable of infecting the barberry. Some of these are strictly confined to one or other of the four common cereals, others can infect two or more of them, and yet others can infect various of our common wild grasses as well.

The fact that what has usually gone by the name of *Puccinia graminis* is an aggregate of several species is in itself startling enough, but this was not unexpected; the demonstration that varietal forms exist so specially adapted to their host that, although no morphological differences can be detected between them, they cannot be transferred from one cereal to another, points, however, to physiological variation of a kind met with among bacteria and yeasts, but hitherto unsuspected in these higher parasitic fungi. It now appears that we must be prepared for similar specialisation of varietal forms among *Ustilagineæ* as well as among other *Uredineæ*, as follows from the results obtained by Kellermann and Swingle in America, by Klebahn, Tubeuf, and others in Germany, and by Plowright and Soppitt in England.

Not less remarkable is the conviction that among the many different pedigree varieties of wheat, some are more susceptible to attacks of rust than others. This had often been asserted in general terms, but the extensive observations of Cobb in Australia, and the even more extensive and exact experiments of Eriksson in Sweden, seem to put the matter beyond doubt.

Of course attempts have been made to account for these differences in predisposition to the attacks of wheat-rust.

N. A. Cobb, who has done much for the investigation of Australian wheat-rusts, regards the different susceptibility to rust as due to mechanical causes, and seeks to explain it by the difference in thickness of the cell-walls on the upper and lower leaf-surfaces offering different resistance to the outbreak of the spore-clusters; the average number of stomata per square millimetre differing in the different sorts of grain, influencing the predisposition to infection; the presence of waxy bloom affording a protection, and so on.

Eriksson and Henning have made a critical examination of Cobb's mechanical theory, and show that, for Sweden at any rate, the conclusions of the Australian investigator cannot be confirmed.

Nevertheless, the problem remains. As matter of fact, different sorts of wheat, of oats, of barley, and of rye are susceptible to their particular rusts in different degrees, and the question is, Why? Some complex physiological causes must be at the bottom of it.

Sorauer pointed out in 1880 that every change of vegetative factors induces differences in composition and form of a plant, and therefore alters the predisposition of each individual and variety; and this applies to the fungus as well as to the host.

De Bary's proof, in 1886, that a Peziza succeeds in being a parasite only after saprophytic culture to a strong mycelium, that its form is altered thereby, and that probably a poison is excreted, throws side-lights on the same question; while I myself showed that similar events occur in the case of the lily disease.

Reinhardt, in 1892, showed that the apical growth of a Peziza is disturbed and interrupted if the culture solution is concentrated by evaporation or diluted; and Büsgen, in 1893, showed that *Botrytis cinerea* excretes poison at the tips of the hyphæ, confirming my results with the lily disease in 1888, and that a similar excretion occurs in rust-fungi.

De Bary had also shown, in 1886, that the water-contents of the infected plant influence the matter; and I may remark that we have here also to consider the case of *Botrytis* attacking chrysanthemums, &c., in autumn, with respect to the chilling of the plant, which lowers the vitality of the cells and causes plasmolysis, as well as the fact that cold increases the germinating capacity of spores, as Eriksson showed.

I discussed these points at some length a few years ago in the Croonian Lecture to the Royal Society, and it now remains to see if any further gleams of light can be found in the progress of discoveries during recent years.

You are all no doubt familiar with Pfeffer's beautiful work on chemotaxis, and with the even more fascinating experiments of Engelmann, which prove that bacteria will congregate in the neighbourhood of an algal cell evolving oxygen.

When Pfeffer took the matter up in 1883, he was interested in the question as to the stimulating action of various bodies on mobile organisms, for he found that many motile antherozoids, zoospores, bacteria, &c., when free to move in a liquid, are vigorously attracted towards a point whence a given chemical substance is diffusing.

Pfeffer's problems had nothing to do with those of Engelmann; he was concerned, not with the proof of oxygen evolution or the movements of bacteria as evidence of the presence of that element, but with a fundamental question of stimulation to movement in general.

Pfeffer found that the attractive power of different chemical substances varies according to the organism, and according to the substance and its concentration. He also showed that various other bodies besides oxygen thus attract bacteria—*e.g.* peptone, dextrose, potassium salts, &c. These experiments are by no means difficult to repeat, and are now employed in our laboratories.

During the course of several years not only were these facts confirmed, but it was also shown that this remarkable attraction—chemical attraction, or "*chemotaxis*"—is a very general phenomenon.

Pfeffer had already shown that swarmspores of the fungus *Saprolegnia* are powerfully attracted towards the muscles of a fly's leg placed in the water in which they are swimming about, and pointed out that in many cases where the hyphæ of fungi suddenly and sharply bend out of their original course to enter the body of a plant or animal, the cause of the bending lies in a powerful "*chemotropic*" action due to the attraction of some substance escaping from the body.

This idea of an attractive action between the living substance of two organisms growing in close proximity was not entirely new—it was, so to speak, in the air—*e.g.* the fusions of mycelial cross-connections and clamp-organs, and of the spores of *Tilletia*, *Entyloma*, &c. One of the most striking examples is afforded by Kihlmann's demonstration of the parasitism of *Melanospora* on *Isaria*, where he states that some attractive action exists. In 1882 I had myself seen zoospores of *Pythium* suddenly dart on to the cut surface of a bean-stem, and there fix themselves. But it is due to Pfeffer and his pupil Miyoshi to state that they were the first to demonstrate these matters clearly.

To understand the important consequences which followed, I must now refer to another series of discoveries.

When a spore of a parasitic fungus settles on a plant, it frequently behaves as follows. The spore germinates and forms a slender tube of delicate consistence, blunt at the end and containing colourless protoplasm. De Bary long ago showed that such a tube—the germinal hypha—only grows for a short time along the surface of the organ, and its tip soon bends down and enters the plant, either through one of the stomata or by boring its way directly through the cell-walls. Several observers, and among others myself, remarked how the phenomena suggested that the end of the tube is attracted in some way and by some force which brings its tip out of the previous direction, and De Bary even threw out the hint that this attraction might be due to some chemical substance excreted by the host-plant. I myself showed that the condition of the attacked plant affected the ease with which the tube penetrates

the cell-walls, and that the actual boring of the cell-walls is due to a solvent enzyme secreted by the tip of the fungus, and in clearly demonstrating this excretion of an enzyme capable of dissolving cellulose carried a step further what was so far known, principally from De Bary's researches, as to this process. In 1892, Reinhardt showed that the tips of hyphæ curve over towards spores they are about to attack, and found that sugar-gelatine of greater strength attracts them from the same medium with a smaller proportion of sugar.

Miyoshi then showed, in 1894, that if a leaf is injected with a substance such as ammonium-chloride, dextrine, or cane-sugar, all substances capable of exerting chemotropic attraction on fungus-hyphæ, and spores of a fungus then sown on it which is *not parasitic*, the hyphæ of the fungus penetrate the stomata and behave exactly as if the fungus were a true parasite.

This astounding result throws a clear light on many known cases of fungi which are, as a rule, *not* parasitic, becoming so when the host-plant is in an abnormal condition—*e.g.* the entry of species of *Botrytis* into living tissues when the weather is cold and damp and the light dull; the entry of *Mucor* into various fruits, such as tomatoes, apples, pears, &c., when the hyphæ meet with a slight crack or wound, through which the juices are exposed. Nay, I venture to suggest that it is even exceedingly probable that the rapid infection of potato-leaves in damp weather in July is not merely traceable to the favouring effect of the moisture on the fungus, but that the state of super-saturation of the cell-walls of the potato leaf, the tissues of which are now unduly filled with water and dissolved sugars, &c., owing to the dull light and diminished transpiration, is the primary factor which determines the easy victory of the parasite, and I suggested some time ago that the suppressed life of *Ustilagineæ*, in the stems of grasses, is due to the want of particular carbo-hydrates in the vegetative tissues there, but which are present in the grain.

Miyoshi, in 1895, carried to proof the demonstration that a fungus-hypha is really so attracted by substances on the other side of a membrane, and that its tip pierces the latter; for the hyphæ were made to grow through films of artificial cellulose, of collodion, of cellulose impregnated with paraffin, of parchment-paper, cork, wood, and even the chitinous coat of an insect, simply by placing the intact films on gelatine impregnated with the attracting substance, and laying the spores on the opposite side of the membrane.

Hyphæ so separated by similar membranes from gelatine to which the attracting substance was not added, did not pierce the membranes, whence we may conclude that it is really the substance referred to which incites the hyphæ to penetration.

Now, obviously, this is a point of the highest importance in the theory of parasitism and parasitic diseases, because it suggests at once that in the varying conditions of the cells, the contents of which are separated only by membranous walls from the fungus-hyphæ, whose entrance means ruin and destruction, there may be found circumstances which sometimes favour and sometimes disfavour the entrance of the hyphæ; and it is at least a remarkable fact that some of the substances which experiments prove to be highly attractive to such hyphæ—*e.g.* sugars, the sap of plums, phosphates, nitrates, &c.—are just the substances found in plants, and the discovery that the action depends on the nature of the substance as well as on the kind of fungus, and is affected by its concentration, the temperature, and other circumstances, only confirms us in this idea.

Moreover, there are substances which repel, instead of attracting the hyphæ.

Is it not, then, natural to conclude that the differences in behaviour of different parasites towards different host-plants, and towards the same host-plant under different conditions, probably depend on the chemotropic irritability of the hyphæ towards the substances formed in the cells on the other side of the membranous cell-walls? And when, as often happens, the effusion of substances such as the cells contain to the exterior is facilitated by over-distension and super-saturation, or by actual wounds, we cannot be surprised at the consequences when a fungus, hitherto unable to enter the plant, suddenly does so.

In spite of all the progress made towards an explanation of the origin and course of an epidemic of rust, however, one serious inconsistency has always puzzled men who have worked with it in the open and on a large scale. This inconsistency concerns the outbreaks of epidemics over large areas, at periods, and within intervals, which do not agree with the weather records and the described biological facts. We know, speaking generally, the conditions of germination of the spores, we know how long infection requires, and the latent period is known: we know much as to the conditions which favour or disfavour the fungus mycelium in the tissues, and, nevertheless, an outbreak of disease over large areas sometimes occurs under conditions which appear quite inconsistent with this knowledge.

During his six years' study of the wheat rusts Eriksson was so impressed with these difficulties that he has lately committed himself to an hypothesis which may perhaps crystallise the ideas which have floated in the minds of several who have been puzzled by these matters.

The facts which seem to have finally impelled Eriksson to his hypothesis were those of the distribution of the wild rusts and grasses. Having learnt which grasses could infect the wheat, oat, barley, and rye respectively, he found cases of epidemics occurring where it was impossible to fit in the facts with the view that spores had been transferred from these grasses within the period required for infection and development of the disease spots. Again, seasons occurred when all the conditions pointed to the probability of a serious outbreak of rust, and no such epidemic occurred. Further, experiments were made in which cereals of varieties known to be susceptible to given rusts were planted in close vicinity to grasses infected with such rusts, and, nevertheless, in seasons eminently suitable for the outbreak of this particular rust on these particular cereals none appeared, or so little that it was impossible to explain the outbreaks of this same rust on this cereal elsewhere, during that season, as due to direct infection from the surrounding grasses.

More and more it became evident that the infective capacity of the rusted grasses is small, and confined to restricted areas, and that the outbreaks in certain seasons—rust-years—must be due to something other than wind-borne spores distributed by gales over the district.

Three hypotheses can be suggested to account for the non-spreading of the disease on to susceptible cereals—(1) Indisposition to germinate on the part of the spores; (2) unfavourable weather for germination; (3) some structural peculiarities of the leaves on which the spores fell, of such a nature that infection was prevented.

The results of many experiments showed that, as matter of fact, the spores are often very obstinate, and refuse to germinate even when the weather is apparently favourable, and Eriksson discovered during these experiments that cooling the ripe spores on ice increased their germinating power. Neither of the other two hypotheses mentioned could be brought into agreement with the results, however.

The conclusion was thus arrived at that an outbreak of rust cannot always be referred directly to the normal germination and infection of wind-borne spores from neighbouring centres of infection.

In some patches of extremely susceptible cereals, the disease appeared simultaneously on plants isolated from all perceptible sources of infection, and on plants not thus protected; the date of outbreak in these cases—reckoned from the sowing of the grain—was far too late to be explained by direct infection from spores on the soil, or on the grain sown. Experiments demonstrated that if such spores had been there, and germinal tubes formed as usual, the disease would have shown itself much earlier.

These and numerous other inconsistencies drove Eriksson to look for an "internal source of infection," in spite of the improbability of any such existing, and of its apparent incompatibility with scientific theory since De Bary's time.

Two methods were pursued. In one each plant of the cereal was enclosed from the beginning in a long glass tube, stuffed with cotton-wool above and below, and so carefully protected against infection from wind-blown spores that we may accept forthwith the improbability of such infection.

Notwithstanding these precautions, the cereal was rusted at the same time as its unprotected neighbours, and equally badly.

Granting the accuracy of the experiments, only two explanations seem to suggest themselves. Either (1) winter-spores attached to the grain had germinated and infected the young seedling—a not impossible event, since several observers have found spore-bearing mycelia in the pericarp of the ripe grains, and we know these spores can conserve their germinating power for months; or (2) the infective material had been handed down to the embryo from the parent plant—an almost inconceivable hypothesis.

To answer this question Eriksson protected his seed-plants

from external infection. and sowed the grains in sterilised soil in specially constructed greenhouses, through which the air can only pass *viâ* cotton-wool filters. Between the double-glass windows water was allowed to stream, and the plants thus kept cool. Some of these protected plants became rusted.

Before we draw any conclusions from such difficult experiments as the above, let us see the results of microscopic examination.

Reference has already been made to the mycelium and spores in the tissues of the pericarp of the grain; no trace could be, or ever has been, detected in the endosperm or embryo. In some cases the seedlings, four to eight weeks old, showed the first uredo-pustules on their leaves, and the mycelium but no spores could be detected in the seed-coats.

The tissues of the leaf, in the neighbourhood of young uredo-pustules, frequently showed curious clumps of protoplasm in the cells, either free in the cell-cavity, or attached to the primordial utricle, and looking like haustoria. Eriksson assumes that we have here the key to the puzzle; he regards these "plasmatic corpuscles" as the protoplasm of the fungus which, after leading a dormant life commingled symbiotically with the living protoplasm of the cell, is now gaining the upper hand and beginning to form a dominant mycelium.

We are therefore to suppose that when the spores of rust, even if of the right variety, alight on the tissues of a wheat-plant, it is a matter decided by external and internal conditions whether the germ-tubes forthwith infect the plant and grow out into a dominant, parasitic, sporiferous mycelium, as we know they usually do, or simply manage to infect the cells with enough protoplasm to live a latent symbiotic life for weeks—or even months—as a *Mycoplasma*, which may, under favourable circumstances, gain the upper hand, and grow out in the form of a mycelium.

This is a startling hypothesis, and brings us to the most advanced point along this line of biological speculation. We must distinguish sharply and clearly between such a view, which is by no means inconsistent with all we know of parasites, so far as the dormant mycelium goes, and all the hazy, mystical suggestions as to "infective substance" and so forth, which were so freely flung about at the beginning of this epoch, and which De Bary's strictly scientific methods put down so firmly.

The idea of symbiosis is now comparatively old, and there are many cases of dormant life now well established. Even the astounding notion of blended protoplasms can no longer be regarded as new. I need only remind you of Cornu's *Rozella*, which invades the thallus of *Saprolegnia* and *Woronina* in *Vaucheria*, the protoplasm of the two organisms apparently blending and living a common life for some time before the true nature of the parasite manifests itself. Eriksson has avowedly been influenced by these and other cases among the *Chrytridiaceæ*. That the remarkable intra-cellular fusions of *Plasmodiophora* and the now well-established symbiosis of the organism of the leguminous root-nodules have also had their influence on his work may well be assumed, and I think we may trace also the effects of our knowledge of the latent life of *Ustilago* during the vegetative period of the attacked cereal.

But there are other cases which prevent our casting aside as impossible the view that Eriksson has put forward.

I showed some years ago that the mycelium of the *Botrytis* of the lily disease can lie dormant for some time in the cell-walls, and I have observations showing that other forms of *Botrytis* which attack roses and chrysanthemums only gain the upper hand when the cold autumn nights so chill the attacked cells that they succumb; the mycelium was there long before, but so long as the cells were active no progress could be made, and only when the plasmolysed chilled cells exude their sap can the mycelium advance.

Many cases of similarly dormant mycelia appear to exist in those cortex and cambium diseases which result in the production of cankers—e.g. *Nectria ditissima* and *Peziza Willkommii*, and Tubeuf's experiments with *Gymnosporangium* are even more suggestive. Tubeuf found that if *G. clavariæforme* is sown on hawthorn seedlings the fungus forms yellow spots and induces marked hypertrophy, and normal spermogonia and æcidia—*Roestelia lacerata*—are developed; but if *Pyrus Acuparia* is used as the host, no yellow spots or hypertrophy result, though a mycelium is formed and will even produce a few starved spermogonia. On allied species of *Pyrus* the fungus may even succeed in forming a few poorly developed æcidia. But on the quince the fungus only just succeeds in establishing an infecting mycelium, and soon dies; and Wagner describes similar events with fungi on *Stellaria*.

These cases point to a struggle between the protoplasm of the cells of the different hosts, and of the fungus respectively: sometimes one wins, sometimes the other. The following cases are also suggestive. De Bary found that the germinal hyphæ of *Peronospora pygmæa*, which is parasitic on *Anemone*, will penetrate the tissues of *Ranunculus Ficaria*, but cannot maintain its hold, and the mycelium soon succumbs and dies.

Still more remarkable and to the point is the following case. Soppitt and Plowright in England, and Klebahn and others on the continent, have gradually unravelled a curious case of heterœcism and specialised parasitism among certain *Puccinias* found on *Smilax*, *Convallaria*, *Paris*, and *Digraphis*. The story is too long to recount in detail, but the *Puccinia-spores* from *Phalaris* were found by Klebahn to refuse to infect *Polygonatum* leaves successfully, though they readily infect the allied *Convallaria*. Close investigation showed, however, that, although the sporidia failed to develop a mycelium in the *Polygonatum* leaves, they really penetrate the cells, and the delicate germ-tube is killed off by the protoplasm, a red spot marking the place of entrance.

The perennial mycelia of Witches' Brooms, æcidia in Euphorbia, *Taphrina*, and many other perennial mycelia are also cases in point.

It is not my purpose to hold a brief for Eriksson's hypothesis, but I may point out that it is in no way contradictory to the facts already known since De Bary's time. Its most serious aspect is with regard to possible treatment, and it is obviously essential that we should have it tested to the utmost, for it must be remembered that no method of spraying or dusting has been, or apparently can be, devised for cereals; hence the questions as to the existence of really resistent forms, and whether dormant mycelia lurking in their tissues have deceived us in these cases also, require sifting to the bottom. Experience, so far, points to the selection of pedigree wheats and careful cultivation as the first necessities; how far the question of spring *versus* winter wheat aids us is still matter for further experiment; early and late ripening are also concerned. Climate we cannot hope to control, but it remains to be seen—when the facts are known—how far it can be "dodged."

Clearly what is needed, then, is experiments with varieties or wheat under all conditions, and we may congratulate the Australian, Swedish, and United States experimental stations on their preliminary efforts in this direction.

I have only been able to give a mere sketch of this rapidly growing subject, but I think you will agree that we are justified in saying that an epidemic of parasitic fungi depends on the interaction of many factors, congenital variations of the host-plant and topical variations of its cell-contents being probably among the most important; and since we cannot hope to control the variations of the parasite, or the meteorological conditions, it behoves agriculturists to pay more systematic attention to the selection of those varieties of the cereal which are least predisposed to rust.

When we find the annual losses from wheat-rust alone put down at sums varying from 1,000,000*l.* to 20,000,000*l.* in each of the great wheat-growing countries of Europe, India, Australia, the United States, and elsewhere, it strikes one as very remarkable that so little should be done to encourage the scientific investigation of these practical questions. I need hardly say that the establishment and maintenance of a fully equipped laboratory and experimental station does not cost the interest on the smallest of these sums.

It should be also clear that in the further development of our knowledge of the treatment of parasitic diseases of plants the farmer, gardener, and forester can alone supply the experimental evidence which will enable us to put theory to the test in the field, garden, and forest. The botanist, by means of his pure cultures of the fungus, can now show clearly what stage in the life-history of a parasite is vulnerable. In his "microscopic gardens" he can show what antiseptics may be employed, how strong they should be, and when and how they should be employed.

But we must not forget that it is one thing to kill a fungus when grown pure, and another to kill it when growing on or in, or even associated with, other plants, without harming the latter. We may compare the first case to the destruction of weeds on a gravel path, where the antiseptic dressing may be employed lavishly and at any time, because there are no

other plants to injure; but it is another matter to kill the same weeds growing in a lawn or a flower-bed, where we have to pay attention to the neighbouring plants.

Experiments in the open, simple in themselves, but conducted intelligently and with due regard to the rigorous demands of science, can alone determine these questions.

Brewers have long known that burning sulphur in the barrels will rid these barrels of the moulds and yeasts growing on their damp beer-soaked sides; and Berkeley saw clearly that sulphur could be applied to the outside of plants on which such fungi as the hop- or grape-mildew, &c., are growing, the critical period being when the spores are germinating, so that the slowly oxidising sulphur should evolve sulphurous acid in just sufficient quantities to destroy the delicate germs without injuring the leaves. And even better results have been attained with Bordeaux mixture.

But it is clear that this can only be done with an intelligent appreciation of the life-history of the fungus, and a knowledge of when the germinating stage is at hand. The successes obtained in France and America with Bordeaux mixture attest this.

It would obviously be absurd to powder sulphur or spray liquids over plants attacked by bunt- or smut-fungi, for we know that the germ-tubes only infect the germinating grain as its first root emerges. Here, as was shown long ago, and especially by the experiments of Hoffmann, Kühn, and De Bary, the practice known as "dressing the grain" must be followed. Knowing that the spores of the fungus are attached to the grain, or to particles of soil around, the efforts must be directed to covering the outside of the grain with an antiseptic which is strong enough to kill the germs but not the grain. If the land is known to be clean, the grain may be immersed in hot water, the temperature being experimentally determined, and high enough to kill the spores but not the wheat, and so on. In these matters also the American stations have done good work.

Neither of these classes of treatment can be adopted, on the other hand, for diseases such as "Finger and Toes," where we have a delicate slime-fungus making its way into the roots already in the soil; but, here again, intelligently devised experiments, such as those of Somerville and Massee, have shown that liming the soil renders it so unfavourable to this disease that it can be coped with.

And similarly with other diseases; the particular methods of dealing with the "damping-off" of seedlings, "dry-rot" in timber, the various diseases of trees, and so on, do and must differ in each case, and the guiding principle must be always the same—having learnt all that can be learnt of the habits of the fungus and of the host, and of the relationships of each to the other and the environment, to see how it is possible to step in at the critical moment and interfere with these relationships in the direction desired by human interests.

The whole matter thus resolves itself into a study of variation —a purely experimental inquiry into complex biological relationships, and it is encouraging to see that this is being understood in the large American and other stations, which are distinguishing themselves by their efforts.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE attendance of British geologists at this meeting of the Association was not large, owing, no doubt, to the counter-attractions of the International Geological Congress in Russia, which drew away also some American geologists who might otherwise have attended. But in spite of this, the section was, on the whole, well attended, and its work was exceptionally arduous and interesting. Though with the exception of the reports of Committees, there were only three papers exclusively British in their scope, the large number of contributions on North American subjects more than made up the deficiency, and gave to this meeting a distinctive character. It is significant of the vitality of earth study on the American side of the Atlantic that the papers should have been, upon the whole, well above the average of other meetings.

Contributions of merely local interest were almost absent, and again and again one was struck by the breadth of view and vigour of generalisation which marked the work submitted to the section. The presence of numerous distinguished Canadian and American geologists, many of the latter coming from the Detroit meeting of the sister Association, furnished an audience ready to grasp and to criticise the views brought forward, and in some instances discussions commenced in Detroit were continued in Toronto. It was, indeed, only the amount of work to be got through which limited the debates. The Glacial papers were exceptionally numerous and full of instruction for the European geologist, while that of Prof. Penck must have had a high interest for American glacialists. It was possible, on the day set apart for these papers, to arrange a series which should span the continent from the Atlantic to the Pacific, and thus to bring before the listener a comprehensive view of the whole bearings of the subject in North America. It is noteworthy that neither in the papers nor in the discussion was there a single dissentient from the view that ice-sheets covering the northern portions of the continent had formed the drifts. This seems to be taken as established beyond all doubt in North America.

Next after the Glacial papers in numbers and importance were those dealing with the Archæan and Palæozoic rocks, these again reflecting the locale of the meeting.

Petrological studies were also fully represented, but Palæontology was comparatively neglected, though a feature of the meeting was the special exhibition of several collections of North American fossils. Those to excite the greatest attention were the beautifully preserved trilobites showing the antennæ and pedal appendages, collected from the Utica Shales of Rome, N.Y., by Dr. C. E. Beecher, and exhibited by Dr. Ami.

The excursions arranged for the geologists were highly successful and most enjoyable. Niagara was visited under the leadership of Mr. G. K. Gilbert, of the U.S. Geological Survey; the inter-glacial deposits of the Don Valley and Scarborough Heights, under the guidance of Prof. A. P. Coleman; while Dr. J. W. Spencer pointed out the main features of the Iroquois Beach, a deformed post-glacial shore-line. Of the long excursion to the Pacific Coast, to which the Canadian Pacific Railway Co. has munificently invited a large party of members, it is at the time of writing too early to speak, but this is being anticipated by all invited as the fitting close of a most enjoyable and memorable meeting. The geologists on this excursion will be under the guidance of their President, Dr. G. M. Dawson, and their Secretary, Prof. A. P. Coleman.

The sectional work of the meeting commenced on Thursday, August 19, with the President's address, an able exposition of the present state of our knowledge respecting the most ancient rocks of Canada, of which, as it has already been given in full in our columns, it is necessary now only to record the favourable reception by the meeting.

Next followed a group of papers treating of the pre-Palæozoic and Palæozoic rocks of North America. Dr. L. W. Bailey described some typical sections in south-western Nova Scotia, in which he showed the succession of the Cambrian rocks of that region and their relation to the granite axis. Dr. R. W. Ells discussed problems in Quebec geology, dealing with the origin of the fundamental gneiss and the Grenville series, and their relations to the Hastings series and the oldest fossiliferous rocks. Mr. J. C. Branner traced the former extension of the Appalachians across Mississippi, Louisana, and Texas beneath the newer rocks.

A most interesting paper at this session was that of Dr. F. D. Adams and Mr. J. T. Nicholson, entitled "Preliminary notice of some experiments on the flow of rocks," in which the authors related how they had placed, accurately-fitting columns of Carrara marble about 4 cm. long by 2 cm. diameter within specially prepared tubes of Swedish iron, and had subjected them to extreme pressure gradually applied. The rock yielded like a plastic substance, and bulged the enclosing tube. In one experiment the column was reduced from 40 mm. to 21 mm. in height, the deformed marble remaining quite firm and compact, though not so hard as the original rock. When sliced and examined microscopically, polysynthetic twinning of the calcite crystals and other indications of strain were observable. These very suggestive experiments are to be continued, and it is certain that all students of dynamic geology will follow the results with keen attention. At a later session Dr. Adams dealt with the structure and origin of certain rocks of the Laurentian system, his conclusions corresponding with those of European workers on rocks of similar type, since he showed by chemical analysis and microscopic examination that the foliated rocks included two distinct and separable types—the one almost certainly highly altered sediments, and the other of igneous origin.

At Friday's session most of the Glacial papers were read.

The wealth of material brought forward left but little time for the final discussion, but the whole sitting was practically a debate on the subject by the authors of the numerous papers. Prof. F. C. Chamberlin led the way with a professedly highly speculative thesis—a group of hypotheses bearing on climatic changes—which turned mainly on the question of the origin and persistence of the various constituents of the atmosphere, more especially of the carbonic acid. The author made a complete departure from the common view, by supposing the atmosphere to have begun as a tenuous envelope which has been subjected to depletion and enrichment during all subsequent time. The author has been led to a rejection of the nebular hypothesis, in favour of the theory of the growth of the earth by the ingathering of solid and gaseous particles. An application of these principles resulted in the conclusion that a glacial climate might be brought about by the impoverishment of the carbonic acid of the air; and a whole cycle of recurrent climatal changes was postulated on this basis.

In his next paper Prof. Chamberlin was content to confine himself to more mundane methods, and gave an able dissertation on the distribution and succession of the Pleistocene ice-sheets of the northern United States, illustrating, by means of a large map, the looped moraines which encircled the terminations of the various lobes. Prof. C. H. Hitchcock described the southern lobe of the Laurentian ice-sheet in New England, laying especial stress on the great uplift of the Laurentian boulders in their southward course, and the divergence of the striæ towards the termination of the lobe "like the barbs of a feather from the central shaft." Prof. H. LeRoy Fairchild discussed the general phenomena of the glacial geology of Western New York, bringing out forcibly the effect of the south-moving ice-sheet from the Ontario-Erie basin in damming the north-flowing drainage south of these lakes, so as to form temporary bodies of fresh-water which emptied southward across the water-shed at every col, cutting characteristic rock-channels now dry. Mr. F. B. Taylor gave an account of the Champlain submergence and uplift, and their relations to the Great Lakes and Niagara Falls, in which the point of chief importance was the description of an old channel by which all the great lakes, except Erie, formerly drained through the Nipissing outlet into the Ottawa river, thus enormously reducing the volume of Niagara, and consequently affecting very seriously any calculation as to the time occupied in the wearing back of the Niagara Gorge. This Nipissing outlet Mr. Taylor believes to have been finally closed by differential uplift, a factor which all the American geologists seem to recognise and allow in relation to glacial and post-glacial geology.

Prof. A. P. Coleman gave a lucid description of the glacial and inter-glacial deposits at Toronto. The recognised importance of these deposits to the vexed question of inter-glacial periods led to the formation of a Committee with a grant of 20*l.* to further investigate their flora and fauna. Dr. J. W. Spencer brought forward fresh evidence from the West Indies and elsewhere in favour of the continental elevation during the Glacial Epoch. At a later session Mr. J. B. Tyrrell, of the Canadian Survey, in a paper of wide scope, under the title of "The glaciation of North Central Canada," gave the result of his prolonged researches in the barren lands west of Hudson's Bay. He concluded that the glaciation of these great plains has been effected by ice radiating at different times from three centres of glaciation: the Cordilleran in the west, the Keewatin in the middle region, and the Laurentide or Labradorian in the east, and that there has been throughout the Glacial Period a progressive shifting westward of the centres of maximum glaciation. He found no evidence to denote any extensive pre-glacial elevation of the region. Mr. Tyrrell's observations cannot fail to modify considerably some existing views as to the cause and growth of ice-sheets. Mr. Bailey Willis, in his paper on the drift-phenomena of Puget Sound, and their interpretation, held that the hollows now occupied by the sea in that region were the casts of glaciers, and not, as has been supposed, the effects of submergence. Mr. Chalmers sent a contribution on the pre-glacial decay of rocks in Eastern Canada, in which were described the thick sheets of decomposed rock, of Tertiary age, which occur in sheltered positions where they have not been removed by glaciation.

Three papers dealing with European glacial geology, which were also read on Friday, afforded a clear indication of the similarity of the phenomena on the opposite sides of the Atlantic. Prof. A. Penck, in a general description of the glacial deposits of the Alps, compared their glaciation with that of British Columbia and Alaska, the glaciers pouring down the valleys to form Piedmont ice-lobes terminated by moraines. He thought that two inter-glacial epochs were indicated, each of much longer duration than post-glacial time, the proportions being stated as 1 : 4 : 6. Assuming the post-glacial period to have extended over 20,000 years, he conjectured that the two inter-glacial periods together occupied 200,000 years, and, from the evidence of the Poe Plain, that the entire glacial and inter-glacial periods lasted 500,000 years. While favouring Richthofen's eolian theory for the loess, he considered that the material had been originally derived from fluvio-glacial deposits. He recognised a slight folding of the older glacial strata, and held that the lakes, which all lay within the limits of the last glaciation, were deformed valleys deepened and widened by the ice-sheet and dammed by its moraines. He noted that there were abundant evidences for the existence of man during the last inter-glacial and glacial epoch; man's antiquity in Europe, therefore, being about 150,000 years.

Prince Kropotkin prefaced his paper on the Åsar of Finland by explaining that his observations were made in 1871, and that the reason for his long delay was that in running away from his fortress-prison at St. Petersburg, he had to leave his MSS. behind, and had only lately recovered them through the good offices of the Russian Geographical Society. He demurred from the prevalent view that the Åsar have been formed in fluvio-glacial rivers, as he had in several instances found that they enclosed a hidden core of true morainic material.

Mr. H. B. Woodward's paper, on the chalky boulder clay and the glacial phenomena of the west-midland Counties of England, brought clearly forward the similarity of these English glacial deposits in their origin with those of North America.

Among the Petrological papers, which were chiefly taken at Monday's session, was that of Messrs. Barlow and Ferrier, on the relation and structures of certain granites and associated arkoses in Lake Temiscaming, Canada, in which they showed that in this region there was a gradual passage from granite to a stratified arkose, as the result of the decomposition and dynamic alteration of the former rock. They concluded that there has been "a pre-existing basement or floor essentially granitic in composition at the base of the Huronian." Prof. W. G. Miller gave a description of some nickeliferous magnetites from Eastern Ontario.

A valuable contribution by Mr. J. J. H. Teall, on differentiation in igneous magmas as a result of progressive crystallisation, was read in the absence of the author. Mr. Teall referred to certain rocks recently collected by the Jackson-Harmsworth expedition in Franz-Josef Land, as proving that magnetite may belong to a very late stage of consolidation, and that progressive crystallisation may lead to a concentration of iron-oxides in the mother-liquor.

The Palæontological papers were not numerous, perhaps partly because some which might be classed under this head were carried to other sections. A note was read from Sir W. Dawson, on certain pre-Cambrian and Cambrian fossils supposed to be related to Eozoon. Mr. J. F. Whiteaves described a Dendrodont tooth from the Upper Arisaig rocks of Nova Scotia, which he thinks may add a second vertebrate species to the Silurian in Canada. Dr. H. M. Ami had an interesting account of some new or hitherto little-known Palæozoic formations in North America, in which the author discussed the successive faunas of Ordovician age in New Brunswick and Nova Scotia. An important contribution from Dr. G. F. Matthew was also read by Dr. Ami, on some characteristic genera of the Cambrian, in which the horizon of *Olenellus* was especially discussed, the conclusion being that its place was above rather than below the *Paradoxides* beds, and therefore not at the base of the Cambrian system.

Mr. A. C. Seward's paper, on the possible identity of *Bennettites*, *Williamsonia* and *Zamites gigas*, explained with the aid of lantern illustrations, completes the Palæontological list.

On Tuesday, among other papers, Dr. E. W. Claypole gave a comprehensive account of the Palæozoic geography of the Eastern States, illustrating by lantern slides the chief geographical and hydrographical changes of the mid-Palæozoic era in that region.

Space forbids notice of the various Committees of Research, though several of these were of considerable interest, notably that on the secondary fossils of Moreseat, Aberdeenshire, by J. Milne and A. J. Jukes-Browne; that on erratic blocks, by

P. F. Kendall; that on the Irish elk in the Isle of Man, by P. M. C. Kermode; and on geological photographs, by Prof. W. W. Watts.

The final meeting of the section on Wednesday was devoted to a joint discussion with Section H, on the first traces of man in North America, in which the President of the Association, Profs. Putnam, McGee and Claypole, and Drs. Dawson and Spencer took part. Though no definite conclusion was reached, the general feeling of the meeting seemed to be against the high antiquity of the reputed finds in the Trenton gravels.

This completed the work of the section, and brought an extremely busy week to a successful termination. The Toronto meeting of the British Association, so far as Section C is concerned, must be regarded as well above the average of recent meetings, both in the quantity and quality of its work, and as one which all the geologists present will remember both with profit and pleasure.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

NATURALLY most of the papers read before Section H related to American anthropology; the following abstracts give some idea of the more important of the communications.

Miss A. C. Fletcher, who has a long and intimate acquaintance with the Omaha, gave a couple of papers on the Scalp-lock and the import of the totem among that tribe. Her sympathetic studies have thrown considerable light upon the religious conceptions of these people, and she has demonstrated that they can compose highly dramatic songs and music. In the legend of the Sacred Pole of the Omahas, we are told, "The people felt themselves weak and poor. Then the old men gathered together and said, 'Let us make our children cry to Wakonda.' So all the parents took their children, covered their faces with soft clay, and sent them forth to lonely places. The old man said, 'You shall go forth to cry to Wakonda. When on the hills you shall not ask for any particular thing; whatever is good, that may Wakonda give.'" Thenceforth on arriving at puberty the youth went fasting among the hills till he fell into a trance; whatever he then beheld in his sleep would be the special medium through which he could receive supernatural aid. This was his personal totem. He then banded himself with those who had received similar visions, and who formed a brotherhood or religious society. These were probably the most primitive social organisations. A further integration resulted in the grouping of brotherhoods into gentes, who practised exogamy and traced descent through the father. Each gens had its totem, which was probably that of the original founder of the gens.

The gentile totem gave no immediate hold upon the supernatural, as did the individual totem to its possessor; it served solely as a mark that the individual belonged to a definite kinship group from which he could never sever himself without incurring supernatural punishment.

The child entered into the gens by means of the ceremony of hair-cutting. As recently practised this rite consisted of two parts, of which the first was confined to boys. A child was presented by his mother to Thunder priest with the words, "I desire my child to walk long upon the earth, I desire him to be satisfied with much food, we seek your protection, we hold to you for strength." While singing a song the priest cut a tuft of hair from the crown of the head, and laid it away in the sacred case. The hair typified the life of the boy, which was thus symbolically entrusted to the safe-keeping of the Thunder god. The child thenceforth passes out of the simple relation he bears to his parents, and by this act is re-born into the tribe and becomes a recognised member of the tribe. The sign of this consecration is the small lock of braided hair, which is isolated from the rest, and to which is fastened the talisman and the war honours worn by the warrior. It was this lock that was cut from the head of a slain enemy and formed the central object in the triumph ceremonies, since it pre-eminently represented the life of the vanquished enemy. The second part was common to all children. In a symbolic ceremony the child was turned in the four quarters in order to place it in relation with the elements, and thus to ensure long life and prosperity.

Probably the turning ceremony was the more primitive portion, so that the sequence may have been much as follows: A child was put into harmonious relation with its environment by the rite of the "turning of the child." Then a boy was placed in the safe-keeping of the Thunder god, by means of the "hair-cutting" rite, that he might become a brave defender of his people. The need of the assistance of supernatural forces led to the "vision rite," with its consequent totem. Those having the same totem naturally formed brotherhoods, and which acknowledged spiritual affinities, and lastly kinship was recognised and relatives were bound together by a common totem, and the restrictions of a common tabu. This important paper will shortly be printed in full by the Anthropological Institute.

Mr. C. Hill-Tout presented a long folk-tale, entitled "Sqaktktquacht, or the Benign-Faced"—an interesting hero-tale of a clever younger brother who went about doing good. He was the youngest of three brothers, who were the children of the red-headed woodpecker and his wife, the black bear. This saga will be published by the Folk-lore Society.

A legend concerning Scar-face, which is believed by the Algonquian Blackfeet to explain the origin of their principal sacred ceremonies, was sent by Mr. R. N. Wilson. So much ritual has reference to this myth, and so many observances are founded upon it, that the student of Indian religious thought may accept it as one of the most significant and instructive of their legends. A beautiful Indian girl refused many suitors, but promised to marry one young man if the scar that disfigured his face could be removed. After a long journey he came to where the Sun lived with his wife, the Moon; their son, the Morning Star, befriended Scar-face. The Sun healed him and retained him until he had been taught many religious ceremonies. Eventually he returned home, married the girl, and taught the ceremonies to his tribe, and the Sun, as he had promised, was kind to the people and heard their prayers. Mr. Wilson's other paper gave a detailed account of Blackfoot Sun-offerings. The tribal religious ceremonies are performed by "prayerful" men; they are not members of any society, but simply individuals of an extremely religious temperament gifted with a good memory. There is no medical priesthood, as has been inaccurately stated. The Sun is pre-eminently the Blackfoot divinity; they may have had more ancient deities, but the "Creator" was never heard of by them until the advent of the missionaries. An account of the life of the Blackfoot women was given by the Rev. J. Maclean. According to Mr. Stansbury Hagar, who presented a paper on the star-lore of the Micmacs of Nova Scotia, the Micmacs believe the stars to be the camp fires of the inhabitants of the sky. The larger fires are before the dwellings of the chiefs, and around them are grouped the lesser lights of the people who bear the same totem name. The Milky Way is the road between heaven and earth. The four stars of the body of the Plough are known as the Bear. He is pursued by seven birds (the three stars of the Plough-handle, Arcturus and γ, ϵ, and η of Böotes). Near the second of these hunters is a faint star representing the kettle in which the bear is to be cooked. Behind them the Northern Crown with μ and γ of Böotes form a typical den. In the spring the bear is seen climbing out of his den; in summer he runs across the sky; in the fall, overtaken by his pursuers, he is wounded with an arrow and totters to the ground; in winter he lies dead upon his back, but with the following spring returns to life, and so the cycle continues eternally.

Dr. W. J. McGee gave a graphic account of the Seri Indians of the Gulf of California. This very ancient tribe has been so isolated that it had never before been studied. These cannibals are extremely active and warlike; they use poisoned arrows, and owing to their bellicose disposition they are now nearly extinct. They are more distinctly matriarchal than any other tribe, and were originally monogamous, though now they are polygamous. They live entirely by fishing and the chase, and have no agriculture. Their implements are natural stones, which by use may become pounded into more serviceable shapes; for these the term "protolithic" was suggested. A cultural art has been but recently acquired, as there is no name in general use for the chipped arrow-points that they now employ.

The Kootenays and Salishans of British Columbia were described by Dr. A. F. Chamberlain; though allied in many respects, they belong to two distinct linguistic stocks. The former are intensely democratic and without complicated secret societies or totemistic clans. Sun-worship is strongly developed among them. A large series of interesting Kootenay drawings was exhibited by the author.

A summary of the twelfth report of the Committee appointed to investigate the North-western tribes of Canada, by

Dr. Franz Boas, was read. This closes a very valuable piece of work which was instigated at the first meeting of the Association in Canada.

Mr. E. Sidney Hartland gave a comparative account of hut-burial among the American aborigines and other peoples, and its probable significance. The origin of the custom must be sought for in the savage idea of kinship, and in the desire to retain within the kin the deceased and all his power and virtues.

The papers on physical anthropology, or somatology, as our American colleagues call it, were four in number, the most important being two papers by Prof. A. Macalister. In dealing with the causes of brachycephaly, he pointed out that those brain areas are the first to increase which will be earliest called upon to work; thus the area which presides over the skilled movements of the arm develops before that which is connected with similar movements of the leg. The central parietal and temporal lobes grow quickest, and thus in the majority of cases we find an infantile brachycephaly. By the end of the first dentition the frontal length and parietal height increase. About the end of the first year the brain ceases to be free and untrammelled by its envelope, and a contest begins between brain and bone. The hitherto broad open sulci become narrowed and linear. In the English child the change from brachycephalism to mesaticephalism takes place shortly after completing the first dentition. Two types of brachycephaly may be distinguished: (1) Primary, due to the retention of fœtal proportions of the components of the brain, and hence short-headedness accompanied by microcephaly. (2) The secondary brachycephaly is due to increased frontal growth, and is usually associated with megacephaly. The second paper gave a *résumé* of a study of the brains of several Australian aborigines, and exhibited a number of photographs and drawings. He demonstrated that these brains were not deficient in those areas that were implicated in regulating the movements of the limbs, or in the sensory centres; but that there was a disproportionate lack of development of those regions which are known as the association centres.

In a paper detailing an experimental analysis of certain correlations of mental and physical reactions, Prof. Lightner Witmer gave the following statistics relative to rate of movements.

Rate of movements in	American males.		American females.		Indians.	
	Right arm.	Left arm.	Right.	Left.	Right.	Left.
Flexion ...	77	78	163	154	132	124
Extension	107	110	197	194	150	153
Minimum	77		154		124	
Maximum	110		197		153	
Reaction time to						
Sound ...	123		154		121	
Light ..	136		146		137	
Electric shock	117		131		117	

He stated as the results of his experiments, that women were deficient in will power, and do not know how to move so rapidly as men. They also felt more responsibility, while making these experiments, that is, they were more self-conscious. When experiments on sensation for pain were made, there was a tendency for the females to anticipate the sensation, and for the men to deny they felt it at all.

A prominent feature of the session were two discussions, in which the American anthropologists present took a prominent part. The first was on the evidences of American-Asiatic contact, and the second was a joint discussion with Section C (Geology) on the first traces of man in the New World. The former was led off by Prof. Putnam giving an account of the origin, aims and organisation of the Jesup expedition to the North Pacific. The object of this extremely important and well-planned expedition is to minutely study the natives of the North-west coast of Canada, those of Alaska and of the corresponding coasts of Siberia, and thus to endeavour to gain accurate data towards the solution of the problem of the origin of the American aborigines. The funds for the expedition, which will be six years in the field, have been supplied through the munificence of Mr. Jesup of New York. The discussion was very animated, and was joined in by the President of the Section, Messrs. Morse, Cushing, McGee and Chamberlain. Prof. Morse argued strongly against any cultural influence between Asia and America, appealing to the distinctness in the pottery, roofing tiles, method of arrow release, &c.; and to the absence in America of the thumb-ring in archery, of the chop-sticks, plough, potter's-wheel, and tea. Cushing argued on the same side, though he believes in a primitive Asiatic origin of the Indians. He said if there is a science of anthropology it must be demonstrable that the development of man is according to certain fixed laws, and hence there must be some similarity between different peoples in an analogous stage of culture. In his reply Putnam referred to the distribution of jadite and nephrite implements, and still maintained that there had been more Asiatic influence than most of the speakers admitted.

Not less interesting was the discussion of the antiquity of man in America. This was opened by Prof. F. W. Putnam, who gave an account of the excavations in the Trenton gravels, and of the argillite implements that were found in the lower beds. Prof. E. W. Claypole narrated the discovery of a polished stone implement in the Drift of Ohio (*cf.* NATURE, vol. lv. p. 350). Sir John Evans argued that the Trenton finds were all neolithic, and that palæolithic forms were absent from America, though widely spread over the Old World. The true test of a Palæolithic age was the occurrence of animals now extinct. Dr. J. W. Spencer stated that the Lafayette beds followed the Glacial Period, as they contain some re-arranged glacial deposits; then came a period of elevation and denudation, in which the Columbian beds were deposited. Later there were several oscillations of level, during some of which the Trenton gravels were formed. The Trenton gravels may be older than the Falls of Niagara (to which he gave 32,000 years), and he believed they were deposited between 5000 and 50,000 years ago. Dr. McGee believed that the gravels were a wind-blown formation, and stated that Prof. Holmes had failed to find a single artificial object in the undisturbed Trenton gravels, but such objects were found in the talus. Few geologists think implements occur in the gravels. He did not lay much stress on the argument based on the argellite implements. Argellite quarries have long been worked by the Algonquins, and plenty of their rejects have been considered as palæoliths. Prof. Putnam, in his reply, said Sir John Evans was wrong in supposing that neoliths were found in the gravels. The various forms of European palæoliths could be easily matched in numbers in America; but it must be remembered that the European examples are made of flint, but as there is no true flint in America we must not expect a very close correspondence. He again emphasised the preponderance of argellite implements in the lower beds, and alluded to the presence of 99 per cent. of argellite implements in the oldest parts of the shell-heaps of New Jersey.

The genesis of implement-making was the subject of a thoughtful and suggestive essay by F. H. Cushing. He believed that anthropoidal man, who arose somewhere about the Indian Ocean, was coaxed down from the trees by the abundance of food along the shores of the sea, and there, by his own domestication, sowed seeds for variation. Manual dexterity set at naught all the effects of previous evolution, and henceforth evolution became more psychical than physical. As a psychic effect of the upright position, the nascent human beings now looked, for the first time, into the face and eyes of their mates, and conscious love was begotten, then volitional selection began to replace mere sexual selection, and language became possible. For a long period man was "prelithic," and supplemented his teeth and nails with the fangs and claws of wild animals. Stones were picked up and used as occasion required without any preliminary dressing. At first, judging from the actions of monkeys and children, the bones and nuts were broken upon the stones; later, stones were used as crushing or breaking implements. Some of the bruised stones were found to be more effective than others, and these would be treasured, and soon it would occur to people to intentionally fracture stones so as to resemble these. It is possible that some of the earliest implements to be manufactured were made in imitation of the sharks' teeth that they picked up on the shore and used as implements. In employing flint implements on bone or horn it would be discovered that the bone actually worked the flint, and so the removal of flakes by pressure would be found to be more effectual than by hammering, and

thus the neolithic technique was arrived at and perfected. Certainly some chipped tools would be worn smooth by use; and if these proved more useful, the actual process would be definitely repeated. In early Palæolithic times man made an important conquest and captured fire, which he kept and fed to protect himself from wild animals and from cold. The domestication of fire was the beginning of the conquest of nature. Later a tacit understanding arose between primitive man and the dog. Mr. Cushing gave a demonstration on some of the early stages of stone implement-making in illustration of his paper.

Several lantern demonstrations were given in the afternoons, among which may be noted the following:—"The Lake-Village of Glastonbury and its Place among the Lake-Dwellings of Europe," by Dr. R. Munro; "Some Old-World Harvest Customs," by F. T. Elworthy; "The Evolution of the Cart and Irish Car," by Prof. A. C. Haddon; "The Kafirs of Kafiristan," by Sir George Robertson; and "The Mangyans and Tagbanuas of the Philippine Islands," by Prof. Dean C. Worcester.

The sectional meeting was very successful, and it was a great pleasure to the British anthropologists to meet those of their Canadian and American colleagues who attended the meeting. It was a memorable occasion for the interchange of cordial friendship and valuable information.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE current number of the *Chemical News* (September 10) is devoted to descriptions of courses in chemistry at British Universities and Colleges. In a brief introduction to this information, reference is made to "the recognised superiority of German chemists in the quantity of research yearly executed," and attention is called to a pamphlet in which Prof. Dr. F. Fischer recommends that the position in technical chemistry which Germany occupies in comparison with other countries be further extended and secured. It appears that there are in Germany four thousand technical chemists, exclusive of about two hundred others, who study chemistry from a purely scientific point of view.

THE 1897-98 Programme of Technological Examinations conducted by the City and Guilds of London Institute, including regulations for the registration and inspection of classes in technology and manual training, has just come to hand. Year by year, we are glad to remark, this publication increases in size and value. Syllabuses are given of the sixty-seven technological subjects in which the Institute holds annual examinations, and helpful lists of works of reference are appended to them. The questions set in this year's examinations are all printed in the Programme, and they show that the Institute is working wisely and well for the advancement of technical education.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, July.—Newton's theory of kinetics, by W. H. Macaulay, is a discussion of Newton's Scholium to the "definitiones" in the "Principia." Galileo, in his study of the motions of falling bodies and projectiles relative to the earth, though he eliminated the effects of friction and of the resistance of the air, did not introduce any correction involving the earth's rotation. Mr. Macaulay, after referring to Newton's letter to Hooke (Ball, "Essay on Newton's Principia," p. 142), summarises the chief points laid down in Newton's first and second chapters, and notices how difficult Newton's task was, and attempts to clear away some of the difficulties.—The decomposition of modular systems of rank n in n variables is a paper presented by Prof. E. H. Moore to the Chicago section of the American Mathematical Society.—An interesting note upon the biquadratic, entitled "On a solution of the biquadratic which combines the methods of Descartes and Euler," by Dr. McClintock, read at the May meeting of the Society, employs a resolution which is new to us.—Dr. L. E. Dickson contributes a paper on higher irreducible congruences, which in part runs on parallel lines with the "beautiful" developments of Serret ("Algèbre Supérieure"), and in part is quite independent and so is worked out in some detail.—Prof. Van Vleck gives an extended review of Dr. Max Stegemann's editions of Kiepert's "Grundriss der Differential- und Integral-Rechnung" (the former in its seventh and the latter in its sixth edition). The work, with some slight blemishes, appears to be a most valuable work of reference, and it is to be hoped that its good points may be made available to English students.—A short notice, by Dr. Stabler, follows of A. Arnaudeau's "Projet de Table de Triangulaires de 1 à 100,000." E. de Joncourt's tables (published at the Hague in 1762) go from $n = 1$ to $n = 20,000$ in the formula $\frac{1}{2}n(n + 1)$. The present tables "are a valuable and interesting addition to the tables now in existence for facilitating multiplication," and are "a great advance over any previously published table of triangular numbers."—Notes, a long list of new publications, list of papers read before the Society (giving places of publication of the same), and index to the volume close the number.

IN the *Journal of Botany* for August, Messrs. W. and G. S. West complete their revision of Welwitsch's "African Fresh-water Algæ," a collection which has proved remarkably rich in new forms, including a very large number of new species and not a few new genera. The collection comprises 300 species distributed over 77 genera.—In the number for September, Mr. F. Townsend commends a monograph of the British species of *Euphrasia*, founded on Wettstein's classical monograph of the genus.—Mr. J. Lloyd Williams records the interesting discovery that the antherozoids or pollinoids of *Dictyota* and *Taonia* are not, as has hitherto been supposed, immotile, but are provided with cilia and endowed with motion.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 6.—M. A. Chatin in the chair.—On the number and symmetry of the fibro-vascular bundles as a measure of the organic perfection of vegetable species, by M. Ad. Chatin. This paper treats of the perigynous *Gamopetalæ*, the hypogynous *Gamopetalæ* or *Corolliflorae* having being considered in a previous communication.—On Bessel's functions $O^n(x)$ and $S^n(x)$, by M. L. Crelier.—On the hypocycloid with three cusps, by M. Paul Serret.—The magnetic deviation of the kathode rays and X-rays, by M. G. de Metz. The author continues his study of the magnetic deviation of these rays and, under different experimental conditions, obtains results similar to those described in a preceding note.—Influence of the X-rays on the luminosity of gases, by M. A. de Hemptinne. The action of electric vibrations causes gases to become luminous at a low pressure, but if the gas is, at the same time, submitted to the influence of the X-rays the luminosity appears at considerably higher pressures. Numbers are given for hydrogen and oxygen gases, and for a few organic compounds.—The composition of potatoes, by M. Ballard. Analyses of a number of varieties are given. The amount of water is found to be closely connected with the nature of the soil, and to be independent of the variety and the size of the tuber.

CONTENTS.

THURSDAY, SEPTEMBER 23, 1897.

EXPERIMENTAL EMBRYOLOGY.

The Development of the Frog's Egg. By T. H. Morgan. Pp. x + 192. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897).

Ueber Verwachsungsversuche mit Amphibienlarven. Von Dr. G. Born. 8vo. Pp. xi + 224. (Leipzig: Wilhelm Engelmann, 1897).

THE theories of Roux and Weismann concerning the significance of nuclear division have been the cause of much useful work. The attempt to decide experimentally whether the early divisions of a fertilised egg are in fact accompanied by a qualitative separation of nuclear or other "determinant" material has led to the remarkable observations of Roux, Driesch and others upon the behaviour of isolated blastomeres, and upon the effect of destroying one or more blastomeres in a segmenting egg. Prof. Morgan has attempted to collect the results of such observations in a form convenient for students. His book contains a fairly full account of the maturation, fertilisation and cleavage of the Frog's egg, but the later stages of development are treated very briefly indeed, the main purpose of the work being a discussion of hypotheses such as those of Roux and Weismann in the light of recent experiment.

The difficulties in the way of a belief that the early divisions of the egg are accompanied by qualitative separation of "determinant" substances are largely increased by the demonstration that in any single blastomere, removed from the egg at a sufficiently early period, is capable of giving rise to an embryo which is not apparently abnormal except in point of size. Prof. Morgan devotes more than a third of his book to an account of the experiments which lead to this conclusion, and to the equally interesting experiments which show that under certain circumstances the first two blastomeres may remain in contact, and yet each of them may give rise to a separate individual. The book is provided with a useful bibliography.

Whatever be the process by which the result treated by Prof. Morgan is arrived at, there is no doubt that in many animals each of the early blastomeres can by proper treatment be made to produce an apparently complete larva, while at a later stage in development the removal of any group of cells involves the production of a defective individual. Prof. Born has undertaken an elaborate series of experiments in order to find out at what stage of development this change in the properties of embryonic tissues takes place. The first results of his work, recently published in the *Archiv für Entwicklungsmechanik*, are now reprinted as a separate volume.

Prof. Born has worked with the larvæ of Amphibia, and chiefly with *Rana esculenta* and *Bombinator igneus*, starting with unhatched larvæ shortly after the closure of the medullary groove. Such larvæ may be removed from their gelatinous cases for purposes of operation, and reared in "normal" salt solution until the proper hatching time, when they may be gradually transferred to fresh water. After treatment of this kind, many of Prof. Born's larvæ have metamorphosed into apparently healthy frogs.

The first results are an extension and confirmation of an old statement made by Vulpian, that the tail of a newly-hatched tadpole will continue to differentiate after being cut off from the body. The tail, cut away from an unhatched larva, and grown in salt solution, continues to exhibit histological differentiation and growth, with a very slight amount of "regenerative" formation of new tissue in front of the point of section. Dorsal and ventral fin, medullary tube, notochord, all the various organs proper to the excised tail differentiate in a nearly normal way, the principal abnormality due to the section being the closure of the nerve tube and the growth of a layer of ectoderm over the cut surface. The growth and differentiation seem to go on normally until the yolk contained in the tissues is used up, when the whole structure naturally dies of starvation. In the same way, the excised head will continue to grow and to differentiate until starvation occurs, without regenerating the hinder part of the body; the amount of differentiation which takes place before death being indicated by the statement that in the oldest heads a complete chondrocranium was formed. What is true of the head is true of segments cut out from the middle of the body: and as Prof. Born says:

"Die Entwickelung jedes Organes, bis zur Schnittfläche, so gut wie bei der normalen Larve, fortschreitet, mag die Schnittfläche liegen, wie sie will. . . . Dabei ist noch Folgendes zu bemerken. Röhrenförmige Organe, wie Rückenmark, gehirn, Vornierengänge, ja sogar mitunter der Darm schlieszen sich an der Schnittfläche ab."

An obvious defect of these experiments is that they fail to show how far development would go, if a proper arrangement for feeding the excised tissues could be devised. Prof. Born has, therefore, made a larger and even more interesting series of experiments, by grafting pieces, taken from the bodies of one set of larvæ, into the bodies of others. For example, the excised hinder end of a larva is attached to the wound produced by slicing away a small piece of the ventral surface of a second larva. After a short time, the ectoderm of the "accessory" tail unites with that of the body of the "principal" tadpole, so that an unbroken ectoderm covers the whole; the nerve-tube of the "accessory" tail closes, and does not appear to develop a communication with the nervous system of the principal larva; the blood vessels of the stock anastomose freely with those of the graft, so that the grafted tail has an abundant food supply. In this way an organism is produced, possessing two tails, and perhaps two pairs of hind limbs. The rate of growth of the grafted tail, &c., may not be the same as that of the corresponding organs in the stock, so that one tail may after a short time be larger than the other; but the rate of histological differentiation is the same, so that if the limb of the graft (as in one case described) remain much smaller than that of the stock, it has not the structure of a limb at an earlier stage of development than that of the stock, but a reduced model of a limb at the same stage of differentiation. This synchronism in the histological differentiation is shown by Prof. Born to occur whenever

two individuals (or parts of them) are so united as to have a common vascular system; and the connection which this result seems to suggest, of a direct relation between chemical change in the blood and histological differentiation in the tissues, opens up a promising field for further work.

The hind end of a larva, grafted in the manner described on to the body of a second larva, can be reared up to the time of metamorphosis. It seems to grow normally, up to the point of section, except that its rectum, if present, communicates with that of the stock. There is apparently little or no nervous connection between stock and graft, since gentle stimulation of the graft causes reflex movement only of that tail, the stock remaining quiescent, and *vice versâ*.

In a similar way an excised head, grafted into the ventral surface of a second larva, may remain without nervous connection with the stock. The two are connected chiefly through the œsophagus of the graft, which fuses with and opens into the alimentary canal of the stock, and by the blood vessels. Such a grafted head shows snapping and respiratory movements, which are independent of those performed by the head of the stock, and have a different rhythm. As before, the grafted head may be larger or smaller than the head of the stock, but the rate of histological differentiation is the same in both.

These experiments go to show that provided a proper food supply be furnished, any portion of a frog larva, after the closure of the medullary folds, will develop in very nearly the same way, whether it be in its normal relation to the rest of the embryo or not, up to the period of metamorphosis. Indeed, the death at metamorphosis appears at least in many cases to be simply caused by mechanical injury which the stock inflicts upon the graft, by scraping it against foreign bodies—a phenomenon obviously connected with the absence of nervous communication between the two. It is especially pointed out that the position of the grafted portion has no obvious influence on the result: so that nothing like the "polarity" observed by Wetzel in his experiments with Hydra, and by others in similar cases, can be seen in the larval frog.

The cases so far mentioned involve the union of comparatively small portions of one larva with the nearly complete body of a second. More complicated unions are effected by slicing a small piece from the ventral or from the dorsal surface of each of two larvæ, and joining the two by their wounded surfaces, so that two nearly complete larvæ are united. The relation between such components follows the same rule as that found to hold for the unions already described: the rate of growth may differ to a considerable extent, but the rate of histological differentiation is always the same. In these cases, and in those presently to be mentioned, corresponding organs, which are in contact at the point of section, unite; and hollow organs, such as gut, nervous system, heart, cœlom, unite in such a way that the cavity of one component communicates with the homologous cavity of the other. In ventral unions, therefore, the two components have a common alimentary cavity, a common cœlom, and often a common heart; in dorsal unions they have a common neural cavity, and so on. When corresponding organs unite, there is generally complete histological continuity of the characteristic tissue of the organ from one component to the other, without any formation of scar tissue, so that nerve fibres run across the line of junction of two brains; gastric epithelium evenly across the junction of two stomachs, and so on.

Detailed descriptions of many of these unions are given, but some of the most interesting are as yet withheld. Some of the results of these unions have been successfully reared through the metamorphosis, and are now frogs. The reasons which have prevented Prof. Born from killing these creatures in order to describe their structure will be easily understood.

A third series of specimens is obtained by uniting the front portion of one larva to the hinder portion of another; and where about each component contains about half a larva, the result seems to be almost indistinguishable from a normal individual. A case is described in which the anterior two-thirds of one larva was united with the posterior two-thirds of the other; the resultant creature has been reared through the metamorphosis, and is now a frog with a trunk of abnormal length.

The way in which corresponding organs unite across the plane of section in cases of this kind is truly remarkable, and induces a belief in some adjustment of the parts after apposition. For example, the pronephric ducts unite so that the cavity of the anterior portion of the duct communicates with that of the posterior portion; and in spite of the very wonderful manipulative skill which Prof. Born must have attained, it is difficult to believe that such minute structures can have been even frequently adjusted by him with absolute accuracy at the time of operation; indeed, in the case of the much larger spinal cord there are sometimes obvious indications of a readjustment.

The last series of experiments described demonstrates the possibility of obtaining some of the results by joining larvæ or portions of larvæ belonging to different species, or even to different genera. Unions are figured between *Rana esculenta* and *Bombinator igneus*.

The experiments are not yet concluded, and it would be presumptuous to do more than describe them; at the same time, their interest is so great that it has seemed worth while to do this at considerable length.

W. F. R. WELDON.

EFFECTS OF HIGH ALTITUDE UPON MAN.

La Cure d'Altitude. Par le Dr. Paul Regnard. Pp. viii + 436. 8vo. 29 plates; 110 figures in the text. (Paris: Masson et Cie., 1897.)

THE hardihood and endurance of mountaineers has been always celebrated. A Swiss Protestant clergyman, Kraenbühl, noticed a great difference between children from the mountains and those of certain schools in Zürich and Bern. He arranged for some of the weakly children from the towns to live at Beatenberg in the mountains, and after some months had the satisfaction of seeing these children much improved; in fact, completely changed for the better. This occurred about 1850, and attracted many delicate persons to

Beatenberg. The present reputation of Alpine health resorts is, therefore, of comparatively recent date, especially so their use as places of residence during winter, and any one visiting Davos to-day would hardly believe that it is only about thirty-two years back since the first invalids came there for their health.

The French employ Alpine health resorts much less than the English and Germans, and therefore Dr. Paul Regnard is all the more to be congratulated on the production of his capital book; it is written in the clear lucid style for which French scientific writers have become celebrated, and it gives us a satisfactory explanation of the principles on which the curative and exhilarating influences of residence in high altitudes depend. The author carries us over the scientific ground pleasantly enough, laying before us, in admirable order, the various observations of practitioners, and the experimental investigations which have been undertaken both in the mountains and in laboratories to explain the action of the phenomena observed. The result of all this work is that the use of mountain climates is no longer empirical, but rests on a well-established scientific basis.

One of the most interesting phenomena observed in human beings and animals, when removed to high altitudes, is the change which takes place in the quality of their blood; and on this subject the author is well qualified to speak, for much of the investigation concerning it has been carried out by his compatriots, and he himself has undertaken several original experiments to settle doubtful points.

Paul Bert discovered that the blood of animals living in high altitudes absorbed more oxygen than that of similar animals at ordinary elevations, and in this observation he was soon confirmed by Müntz, who removed rabbits from Tarbes to the Pic du Midi de Bigorre in the Pyrenees (2377 metres), where they remained close to the observatory on the summit of the mountain, and bred naturally. This was in 1883, and in 1890 Müntz compared the blood of rabbits born on the mountains with that of rabbits of the plain, and found that the former was richer in hæmoglobin, and absorbed more oxygen than the latter. Viault found that at high altitudes the red corpuscles of the blood increased rapidly in numbers, and out of proportion to the increase in hæmoglobin. The work was taken up by Egger and Mercier, of Arosa, and Prof. Miescher, of Bâle, and no doubt was left that the red blood corpuscles notably increased soon after residence in places of high altitude. Egger found that the hæmoglobin was likewise notably increased, but not relatively so much as the number of red corpuscles. When residents of the mountains descended to live in the plain, he found that the number of their red corpuscles fell to the normal. Mercier considered that the degree of increase in the number of corpuscles varied directly with the altitude. Sellier tried the effect on animals of an atmosphere abnormally rich in oxygen. His results were doubtful, but the carefully conducted experiments of Regnard himself seem to establish the fact that when animals are kept for a considerable time in an atmosphere containing too much oxygen, their red corpuscles decrease in number.

It is clear that Dr. Regnard assigns a great part of the effect of mountain resorts to the influence of the altitude on the blood. To illustrate his views, we may take the case of a consumptive person. By life in town and under other unhealthy influences, he has become anæmic and badly nourished; consequently his tissues are less able to withstand the tubercle bacillus, and he becomes infected. He then goes, we may suppose, to some Alpine resort, either directly, or after resting some time at an intermediate station. Owing to the diminished amount of oxygen in the air at high elevations his blood is not able to absorb enough for its proper requirements, and consequently a "reaction" gradually takes place. New "microcytes" are quickly formed, and these develop rapidly into full-sized red corpuscles, and gradually acquire the normal amount of hæmoglobin. Thus the blood becomes richer in red corpuscles and in hæmoglobin; it can absorb more oxygen, and the whole body is better nourished (though fat and comparatively useless material may be lost, so that there may in many cases be an actual decrease in body weight, at first at least), and offers greater resistance to the growth of the bacilli. When the patient descends to lower elevations the number of his red corpuscles slowly returns to the normal amount; the good effects on the general nutrition remain, and the blood, though not so rich in corpuscles and hæmoglobin as it was in the mountains, is of good quality and not below standard, as it probably was when the illness commenced.

Mountain sickness results, according to the author, from the diminished pressure of oxygen in the atmosphere, and its consequent diminution in the circulating blood, at a time, moreover, when on account of the muscular exertion of climbing it is especially needed. It is, in fact, due to asphyxia of the tissues. Prof. Clifford Allbutt and most authorities are practically now agreed that deprivation of oxygen is the essential cause of *mal des montagnes*.

The author believes that a comparative immunity from phthisical contagion is obtained at high altitudes in spite of the presence of phthisical patients and of the "contagium vivum," which the more careless of them scatter about with their expectoration. This he attributes partly to the excellent "sanguinification" of those resident in high altitudes, and their consequent resistance to the bacilli of tuberculosis, and partly to some antiseptic action of the climate which is capable of diminishing the number and virulence of these microbes outside the body.

Though he points out the charms of mountain resorts, Dr. Regnard is careful to speak of trials which sometimes await the visitor. It is in spring when the snow is melting, that the Mediterranean resorts triumph, but then succeeds the rapid growth of vegetation in the mountains, one of the most beautiful sights afforded by nature. The fogs which come with rainy weather cause a moist cold which may be very trying, and these are perhaps the chief drawbacks of the Alps. The dust of the roads at some localities are amongst the drawbacks which disappear during winter, when the ground is covered with ice and snow.

In the second part of the work, that chiefly devoted to an account of the individual resorts, Dr. Regnard is responsible for the new term "Hypsiatrie" (*i.e.* treatment by high altitudes). The localities described have

been visited by the author, and views of many of them are given. We must note one drawback which the volume has, in common with most French books, namely, the absence of an index. F. P. W.

ELECTRO-METALLURGY.

Electric Smelting and Refining: the Extraction and Treatment of Metals by means of the Electric Current. Being the second edition of *Elektro-Metallurgie*, by Dr. W. Borchers. Translated, with additions, by Walter G. McMillan. Pp. xx + 416. With numerous illustrations. (London: C. Griffin and Co., Ltd., 1897.)

THOUGH electro-metallurgy may still be regarded as in its infancy, it is such a lusty youngster and is making such rapid progress that it is high time that a good manual on the subject in the English language should be available to our engineers. No better work is wanted than a translation of Dr. Borchers' well-known treatise, and it has been excellently put into English by Mr. McMillan, who has also done his best to bring the work up to date, a task rendered all the easier by reason of the shortness of the time (considerably less than two years) that has elapsed since the publication of the German edition. The additional matter mainly concerns the practical aspect of the subject, accounts of actual applications of processes to which little or no reference is made in the German text being inserted under many of the subheads. With these additions, enough is stated to give a good general idea of the present industrial position of electro-metallurgy.

Little space is devoted to introductory matter, the author plunging into the thick of his subject almost at once. A short account, however, is given of the newer electrochemical theories, but the student is referred for fuller explanations to the works of Ostwald and Nernst.

In Part i., which deals with the alkali and alkaline earth metals, the most interesting section is that on the carbides of calcium, strontium, and barium. The history of the subject is noticeable, as it differs somewhat from that given by M. Moissan in the *Annales de Chimie et de Physique* last year. Thus Dr. Borchers claims to have produced the carbide of calcium in his electric furnace as long ago as the year 1880, although no use was made of the discovery, which was not published until 1891, until "the later researches of Maquenne, Travers, and Moissan first recalled attention to this class of compounds" in 1892–94. It is remarkable that Moissan, writing at a later date than Borchers, does not refer to the experiments of the latter. The electric furnace used by Borchers differs from that employed by other experimenters in having a thin carbon pencil connecting two thick carbon cylinders. When the current is passed, the carbon pencil becomes intensely heated owing to the great resistance offered by it, and the charge, which is packed round it, is heated by contact. There is here no possibility of electrolytic action, and it is on the results obtained by the use of this furnace that the author, in 1891, based the law, which he claims to have established, that "all oxides are capable of being reduced by carbon if the temperature is sufficiently high"—a law which has not as yet obtained full recognition.

The most important parts of the book are, however, those dealing with aluminium and copper. In both these sections the historical accounts are particularly good, the progress of events in the electrolysis of fused compounds of aluminium, for example, being traced from the experiments of Davy in 1807 to the practical installation of the Hall process at Pittsburg, working details of which were not published until 1896. Many patent specifications are given and processes mentioned, some of them being admittedly impracticable, and even, in the author's opinion, absurd, for "we may learn something even from negative results." The good points in each and the causes of failure are carefully pointed out, with the result that the history is made most instructive. It is true that Dr. Borchers shows a pardonable tendency to praise what is German and to criticise and decry the work in the United States and elsewhere; but the translator has in part corrected the impression conveyed by this patriotic prejudice by the additions made in many parts of the book. It is disappointing that details are not forthcoming of the work of the British Aluminium Company, which we learn is now the largest producer of that metal in the world, using 2500 h.-p. at their Falls of Foyers works in Scotland; but it is, of course, not surprising that manufacturers, after spending thousands of pounds and much time over their experiments, should prefer to keep the results to themselves for a time.

The electrolytic refining of fairly pure metallic copper, like the direct reduction of aluminium from its oxide, is of special interest, because all the main difficulties have now been overcome, and a complete account can be furnished. Here again there is a slight tendency on the part of the author to regard the latest German process, the Siemens-Borchers system, as perfection, and to ignore the later American practice, in which a much higher current density is used, and the cost thus materially reduced, in spite of the fact that wages are higher than in Germany. Several exact descriptions of processes in works are given, however, illustrated by capital diagrams, and the whole section is of great value.

Passing to other metals, silver, gold, lead, tin, zinc, and antimony all receive adequate treatment, and an interesting description is given of the various processes of electric welding, local softening, and soldering of iron and steel.

Among minor errors that were noticed may be mentioned the statement on p. 239, that ores of silver and gold are never smelted with copper ores with the design of concentrating the precious metal in the copper. This method, however, has been in use for some time in New Mexico. Again, the melting-point of gold is given as 1035°, a figure long since abandoned, and some erroneous figures are given concerning the relative cost of the Siemens-Halske and other cyanide processes for the treatment of gold ores. Such trivial mistakes do not impair the value of the work, which must of necessity be acquired by every one interested in the subject who does not already possess the second German edition.

There is much material for reflection for engineers in England in the phenomenal rapidity with which the practical applications of electro-metallurgy are advancing in Germany and in America. The consideration, in particular, repeated in this volume over and over again, to

the effect that too much attention can easily be paid to water-power, is well worth bearing in mind. That such power costs little or nothing is obviously far from being a fact, when one takes into account the cost of the plant and the rent of the waterfall, a rent that will tend to increase more and more as the owners of the ground realise its value. On the other hand, while water-power is sought high and low for electrical purposes, the waste gases from blast furnaces and coke ovens represent surplus energy, which passes away unused in many modern works, to the extent of hundreds, or even thousands, of horse-power units. There is here open, thinks Dr. Borchers, a field which can and will be at once successfully used by electro-metallurgy.

OUR BOOK SHELF.

The Mammoth Cave of Kentucky. An Illustrated Manual. By Horace C. Hovey, A.M., D.D., and R. Ellsworth Call, A.M., Ph.D. Pp. v + 110. (Louisville: John P. Morton and Co., 1897.)

NEARLY a century has passed since the wonderful Mammoth Cave of Kentucky was found by a hunter who entered it in pursuit of a wounded bear. The cave is one of many which occur in the limestone regions of Kentucky and other States of the Central West. It is stated by Dr. Hovey that there are as many as four thousand sink-holes—one covering an area of not less than two thousand acres—and five hundred known caverns, in Edmonson County alone. The Mammoth Cave is not the most interesting from a scientific point of view, nor is it so beautifully decorated with stalactites as the adjacent White Cave, but it transcends the others in the grandeur of its dimensions. So far as is at present known, there is only one entrance to the cave; from it two principal lines of exploration have been laid out, and they are both described in detail in the manual before us.

It is really refreshing to read a guide-book of the kind which Drs. Hovey and Call have given us. Instead of extravagant descriptions of the scenic features, and of imaginary resemblances found in stalactites and stalagmites, we have a fair amount of interesting information on the causes which produce such formations, and on the natural history of the cavern generally. In a section on the geological features of the cave we read (p. 96):

"The rocks which contain Mammoth Cave, and all the caverns surrounding it, are of Sub-carboniferous age. There are but two members of the Sub-carboniferous included in the vertical section, and they are the Chester Sandstone, which forms the immediate surface rock, of varying thickness, and the St. Louis Limestone, largely, in this section, oolitic, in which the great body of the cave is formed. Between these members, but not always present, is a variant layer of conglomerate, from which are derived most of the siliceous pebbles which are found in the floor of the cavern in certain places."

The fauna and flora of the cave are briefly described, and a list is given of the various forms of life which are certainly known to live in the cavern at the present time, the places where they are generally found being also described. Dr. Call has himself collected and studied the animals of the cavern, and has added a number of interesting forms to the list of those previously known. It is pointed out that, with the exception of the blind-fish (*Amblyopsis spelæus*), which was described by Dr. De Kay in 1842, the earliest descriptions of animals from the Mammoth Cave were by Europeans. Two blind beetles, one blind spider, and a blind crayfish were first described by Dr. Tellkampf in 1844.

A map of the cave is appended to the volume, and a number of pleasing plates illustrate various parts and formations. The authors are familiar with every part of the cave, and their scientific training enables them to see and understand more of the nature of things than an untrained observer. We could not desire a better guide-book to the subterranean wonderland of Kentucky than the one they have produced.

The Survival of the Unlike: a Collection of Evolution Essays suggested by the Study of Domestic Plants. By L. H. Bailey. Pp. 515. (London: Macmillan and Co., Ltd., 1896.)

THE book before us consists of a number of addresses delivered during a period extending over several years. They are of unequal merit, but nevertheless are all well worth reading, and some of them are remarkable both for their vigour and the stimulating interest of their contents.

To the evolutionist there is much food for reflection. As Dr. Bailey truly says, the evolution of species is going on all around us, and nowhere can the process be more readily followed than in the case of cultivated plants. He emphasises the extraordinary amount of diversity to be seen within the limits of a species, and indeed even in the different branches of the same tree, and he shows pretty conclusively that in the case of apples, for example, different types which are characteristic for certain regions, may be traced back with certainty to a single parent form. This is of special interest as proving that new races may arise by a process of selection within the limits of vegetative (not seminal) propagation. In fact the author himself goes so far as to say that "there is no essential difference between bud-varieties and seed-varieties, apart from the mere fact of their unlike derivation; and the causes of variation in the one case are the same as those in the other." Further, "that much of the evolution of the vegetable kingdom is accomplished by wholly sexless means." There is no doubt, however, that although we may sometimes hesitate to follow him in his conclusions, Prof. Bailey's arguments merit attention, and will have to be reckoned with. He has a terse and epigrammatic way of driving home his meaning which is refreshing, and he really strikes a note of needed warning in saying, "I sometimes think that we are substituting for the philosophy of observation a philosophy of definitions."

Extremely interesting are the pages devoted to the evolution of some of our vegetables, flowers, and fruits, and, amongst the latter, mention may be specially made of the tomato and the strawberry.

Altogether the book may be commended to a wide circle of readers. It is clear in style as well as forcible in diction, and its author has made good use of a wide range of facts from sources which are not, to every one, readily accessible.

The Eye as an Aid in General Diagnosis: a Handbook for the Use of Students and General Practitioners. By E. H. Linnell, M.D. Pp. 248. (Philadelphia: The Edwards and Docker Company, 1897.)

THE general fact that a person's state of health may be judged from the expression of the eye is well known. In the book before us Dr. Linnell shows that every tissue of the eye at times affords points of diagnostic importance. As he points out, "Examination of the eyes affords valuable aid not only in the diagnosis of diseases of the central nervous system, but also of constitutional affections and diseases of other organs." It is to obtain a wider recognition of the relations of diseases of the eye to general diseases, and to place before the student and family physician the experience of a specialist as to the eye symptoms which are valuable in diagnosis, that this book has been written. The volume will doubtless prove a serviceable handbook of diagnosis to the general practitioner.

The Chlorination Process. By E. B. Wilson, E.M. Pp. iv + 125. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1897.)

THIS little volume bears a strong family resemblance to the book on "Cyanide Processes," by the same author, which has already been reviewed in NATURE. An engineer who has not studied chemistry so much as other subjects naturally encounters difficulties in describing a "wet" or so-called chemical process. For example, on p. 61, the equation representing the formation of gold chloride in cases where bleaching powder is used is given as follows:

$$Au + CaOCl_3 + H_2SO_4 = AuCl_3 + CaSO_4 + H_2O.$$

It is stated further on that "the chlorination process is based upon this reaction." If such opinions are not counted, there is not much that is new in the volume.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

African Language.

IN an exceedingly interesting article in your issue of the 16th, on "Anthropology *versus* Etymology," I am so much struck by the clear statement of the old school mythologist dogma, that "the old name of a deity which had lost its meaning might remind a later generation of the name of some beast; hence might arise those stories of gods taking the forms of beasts," &c. That this is really the case among certain West African tribes I am quite certain, and I believe that, as far as West Africa goes, the confusion caused in white minds by the language has given rise to a good deal that has been said regarding the West African natives believing themselves descendants of animals. It is, I need hardly say, no uncommon thing to find one and the same word used for two or more distinct things. When that word is written down by a white man, who may not notice the accompanying gesture, that marks in which relation it is employed, error is liable to creep in, and you may be calling "slowness in walking" "the new leaves on trees," or *vice versâ*, or "a hundred bundles of bikei" "the butt-end of a log," or, "a finger-snap" "your maternal aunt" among the Bafanh. This also shows as an element of the danger of judging from words alone in the case of the name used by all the Fjort tribe, *who are under the Nkissi school of fetish*, for their great over-lord of gods, *Nzambi Mpungu*. In the Loango and Kacongo districts *Mpungu* means a great ape, and the word is used there also as the name for this great god, the creating god; hence it would be easy, and I hope excusable, for I did it at first myself, to think the great god and the ape had some connection. Nevertheless, they have not Nzambi Mpungu as a name, for the great deity was imported into the Kacongo and Loango from a region on the south bank of the Congo, with the rest of the Nkissi cult, prior to the discovery of these regions by Diego Caõ; and therefore, when the word is used in a religious sense, it bears the religious meaning which it brought from its original home, namely, *something that is above*, or *that covers over*. Mr. R. E. Dennett tells me that Mpungu is used in this sense to this day in the Nlanoi dialects.

The truth is, we are now urgently in need of a Prof. Max Müller for African languages. When attempting to grasp the underlying idea of witch-doctors' methods at Okiyon (among true negroes, I found an alarming state of affairs connected with the so-called word *woka*. The only thing I can liken *woka* to is a nest of spiders, which as soon as you touch it with a stick ceases to be a manageable affair; in *woka* there are representations of at least three sets of opinions bearing on the interrelationships of matter and spirit. I subsequently found ample reason to believe that this was the case with all secret society words; namely, that they were words the full meaning of which were only known to the initiated. The ordinary free man or woman passing through the ordinary course of secret society instruction would only learn the signification of a simple set of them. The full meaning of the strong words are only known to the few men at the head of the society. Having grasped this state of affairs I decided to stick to fishing and the land law, hoping that this mystery was confined to the *strong mouth*; but a few months ago, I having requested Mr. Dennett, of Loango, to send up some of the interesting stories I knew were prevalent among the Fjort tribe, among whom he has lived for seventeen years continuously, he sent me what he calls "the key to the Fjort alphabet," which shows me this strange figurative unworked-at thing lays behind the whole of that language. I have no hesitation in saying Mr. Dennett's MS. is a most appalling work, and it produces great irritation in most patient anthropologists promptly; and what we now require, as aforesaid, is that Max Müller who will give the student of the African great assistance, and then we will hope some great philosopher will come and enable us to have anthropology *cum* etymology and any other ology that will help us to know the whole truth. M. H. KINGSLEY.

100 Addison Road, Kensington, W., September 19.

On Augury from Combat of Shell-fish.

IN your issue of May 13 (p. 30), Mr. Kumagusu Minakata quotes several examples of augury from the combat of shell-fish. In Spencer St. John's "Life in the Forests of the Far East," vol. i. p. 77, amongst various ordeals related by him as being practised by the Sea-Dyaks of Sarawak, he gives the following:—"Another is with two land shells, which are put on a plate and lime-juice squeezed upon them, and the one that moved first shows the guilt or innocence of the owner, according as they have settled previously whether motion or rest is to prove the case." CHAS. A. SILBERRAD.

Etawah, N.W.P., India, August 21.

THE MEUDON ASTROPHYSICAL OBSERVATORY.[1]

THE foundation of this national observatory may be said to date from the time of the return of the French expedition which was sent to Japan to observe the transit of Venus in the year 1874. Since that period the observatory has been content to publish many of the important results of work completed in various journals, chiefly in the *Comptes rendus*, but it is only quite recently that the first of a series of "Annals" has appeared. It is this volume which we propose now to pass under review; but we may preface our remarks by reminding the reader that many of the sections inserted are not published here for the first time, especially those relating to the photography of solar surface details.

M. Janssen opens with a most interesting historical introduction, which sums up the steps which led to the present efficient state of this national observatory, the line of work which has been actively pursued since its foundation, and the instrumental equipment which it now possesses. Neither does he forget to refer to the important *rôle* played by M. Cezanne, an eminent engineer and the principal originator of the French Alpine Club, in proposing and strongly advocating, before a meeting of the National Assembly, the necessity of establishing, near Paris, an observatory for the pursuit of physical astronomy. The suggestion was in due course submitted to the Academy of Sciences, and the committee appointed to inquire into it thoroughly endorsed the advisability of the scheme. It was pointed out that such an institution was not only useful, but necessary and urgent; that the part taken by France in these new studies, their importance, and the novelty of the methods on which they were founded, made them a new and distinct branch of astronomy, and called for a special establishment, where they could be freely cultivated. Strengthened by the discovery of spectrum analysis and photography, physical astronomy became a branch of astronomy of sufficient importance to be pursued with success and developed by itself.

The necessity for the establishment of the institution being thus strongly stated, it was not long before an observatory was provisionally installed at the Boulevard

[1] "Annales de l'Observatoire d'Astronomie Physique de Paris," par J. Janssen. Tome I. (Paris: Gauthier-Villars et Fils, 1896.)

d'Ornano, the place where the Japan expedition had been prepared. The question then arose as to the location of the permanent observatory, there being two available buildings belonging to the Government which could be utilised for this purpose—one at Malmaison and another at Meudon. The latter was finally settled upon, and the partial restoration of the old château in the grounds was commenced on lines suitable for the work to be undertaken.

The most satisfactory manner in which the whole of this undertaking has been completed, will have been noticed by those who have had the opportunity of visiting this charming spot. Those less fortunate may gather a good idea from an examination of the excellent series of heliogravures which form part of this volume. The old château, with its spacious grounds and rooms, has proved suitable in many ways for such a physical observatory. The large instruments have been housed in appropriate domes, while the rooms devoted to researches of several kinds have proved most convenient.

Before referring to the work accomplished, let us briefly make a survey of the instrumental equipment. The large equatorial consists of a twin-telescope with apertures of 0·83 and 0·62 metres, the latter being devoted to photography. These objectives have practically the same focal length, being 16·16 and 15·90 metres respectively. They are set up together on the same mounting, and housed under the large dome situated in the middle, but at the upper part, of the main building. The dome itself is 18·50 metres in diameter, and is rotated by means of electricity, the same motive power being also used for elevating or depressing the observing platform. Two other smaller domes of 7·50 metres diameter, situated in the grounds, contain respectively a Newtonian reflector of 1 metre aperture and a refractor of 0·30 metres aperture. The former has a focal length of 3 metres and was made by the brothers Henry, M. Gautier having undertaken the mechanical parts. This reflector is mounted somewhat after the English system, and is, as Prof. Janssen states, a "précieux instrument de voyage." The solar photographic telescope is described as being of fine optical perfection, and is due to Prazmowski. This instrument will, however, be referred to later on, so we may pass on to those parts of the building set apart for laboratory work.

In restoring the old château, as many of the smaller buildings about it were retained as were likely to prove serviceable on a future occasion. Such, for instance, was the case with the old stables, which measured nearly 100 metres in length, and could be easily extended another 40 metres if thought desirable. These have since been appropriated for a large physical laboratory, and the oak partitions have been preserved in their original positions, serving among other things as useful supports for the long tubes, which are employed in the investigation of gases under pressure. The accompanying illustration (Fig. 1) gives a good general view of this long corridor, and shows how the sides of the horse-boxes have been utilised; three of the long metal tubes can be seen resting on the partitions, and lying along the corridor a considerable distance. These tubes measure 60 metres in length, their diameters being about 0·05 metres. They are joined in sections of 6 metres, and so securely is this accomplished, that for more than six months a pressure of from 20 to 30 atmospheres has been maintained without any sensible leakage. Among the investigations carried on here may be mentioned the determination of the densities and spectra of gases under high pressures.

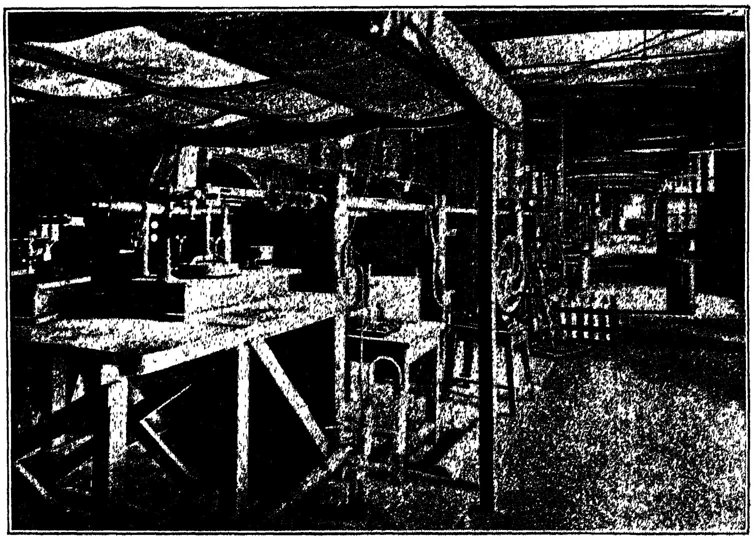


FIG. 1.—The Meudon Stables as an Astrophysical Laboratory.

Coming now to that portion dealing with solar photography, this is of special interest in that the methods and results of a long series of researches are given in a somewhat detailed form. Solar photography at Meudon has attained such a high state of perfection at the present day, that this may be looked upon as one of the chief fruits of the observatory; in fact, quite a new era in this branch of the subject has dawned.

To describe the steps which have led M. Janssen to achieve such a high state of excellence in photographing minute details would necessitate a longer account than we can here afford; we must restrict ourselves, therefore, to the main lines on which success has followed so quickly and so surely.

Investigations on the optical properties of the material to be used for the lens as regards photographic absorption, showed that the glass gave a maximum amount of light very confined in the violet region of the spectrum near the Fraunhofer line G. A study of the sensitiveness of the photographic film was next undertaken, and a film was finally produced which was most active for those rays which M. Janssen desired to employ. The objective was then made so that the images formed at the focus were nearly exclusively composed of rays of the same refrangibility; they were also, as M. Janssen states, extraordinarily sharp. The next point was to produce as fine a grain as possible in the film, and of sufficient delicacy to reproduce all the details of the image exposed on it. The results of these experiments, giving the actual proportions which were finally adopted, are described at some length. It is interesting to note that great stress is laid on the importance of rigorously cleaning the plate in the first instance We read "cette propreté est ici encore plus indispensable que pour les photographies artistiques les plus soignées." Other points of difficulty successfully overcome were: considerable magnification of the image to show the delicate details of the solar surface, and to diminish the effects of irradiation; complete control of the shutter, to ensure sufficient exposure and exemption from irradiation; and, lastly, means of equally exposing all parts of the image.

The photographs obtained by employing the above-mentioned instrument and method were, as a rule, of 0·30 metres diameter, but for special purposes diameters of 0·50 and 0·70 have been used. Some of these pictures have been beautifully reproduced in the volume before us, and surpass any others that have been obtained both in clearness and fineness of detail.

A minute examination of such photographs has greatly enlightened us on many points regarding the surface movement and appearance of the photosphere, and in the near future we shall have series of photographs taken very quickly one after another, which will help us to follow the motions, invisible even to the unaided eye, most closely.

Further, it has been shown that the forms, dimensions, and distribution of the granulations are not in accordance

FIG. 2.—A portion of the solar surface, showing a sunspot and a mean *réseau* (June 22, 1885).

with the ideas formed of these elements of the photosphere as seen through telescopes. The photographic images do not confirm the notion that the photosphere is built up of elements, the forms of which are constant, and resemble rice grains, &c. The granulations, according to M. Janssen, assume different shapes under different circumstances, and vary very much in size.

The discovery of the photospheric *réseau* is another outcome of the Meudon photographs. A close study of the photographs showed that the photosphere was not uniformly constituted in every part, but that it was divided into series of figures more or less separate from one another, and exhibiting a peculiar structure. The sizes of these figures were found to vary, and their contours were more or less rounded, sometimes rectilinear, and very often polygonal. These different types of *réseaux* are clearly seen on the photographs in the volume, and one of these, illustrating a mean type of *réseau*, is given in the reproduction accompanying this article (Fig. 2).

The picture, here considerably reduced, was taken on June 22, 1885, the diameter of the disc being 0·888 metres, and gives a good idea of what is meant by a mean *réseau*. The photograph shows, further, a large spot, the principal nucleus of which measured nearly two minutes of arc in diameter. The faculæ and striæ of the penumbra of the spot illustrate very clearly that these parts were formed of granulations like the rest of the solar surface.

A special inquiry as to the distribution of this granulation over the entire solar surface brought out the fact that even at the poles it was quite distinguishable; it thus differs from the spots, which are limited to two narrow belts on each side of the solar equator.

The last sections of the volume are devoted to several other uses of solar photography, as, for instance, the questions of the presence of a lunar atmosphere, or of small bodies passing between the earth and the sun. Both of these have been investigated at Meudon, and in each case a negative answer was the outcome of the research.

In bringing this notice to a conclusion, we may remark that this, the first volume of the "Annals," is worthy of the institution from which it hails, besides being a valuable contribution to astronomy. It is, perhaps, the most handsome volume of any "Annals" which it has been our lot to notice, and the numerous reproductions of photographs are models of what can be accomplished in this line of work.

The French Government is to be congratulated on being the means by which such fine work in astronomical science can be accomplished, and is, we have no doubt, proud of the able director to whose energy and skill such important advances are due.

WILLIAM J. S. LOCKYER.

RECENT WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

THE Fifteenth Annual Report of the United States Geological Survey opens with a few words of farewell spoken by the Director, Major Powell, on his retirement. Modestly and briefly he reviews some of the work done by himself and his colleagues, which has been expressed in not less than a thousand maps and two hundred volumes. The last Report issued by him is a worthy successor of the earlier ones in material and in illustrations; many of the latter are exceptionally fine, and show what can be done by the artistic printing on high-class paper of blocks processed from good photographs. When will English officialdom learn that the thousands of pounds spent in promoting research lose nine-tenths of their effect on account of the slovenly and imperfect presentation of the results to the public?

One of the most interesting memoirs in this volume, on the Granites of Central Maryland, is prefaced by a short but very able chapter from the pen of Prof. G. H. Williams, whose promising life has been cut off in its prime. Here we see evidence of a firm grasp of his subject, with knowledge and experience amongst the class of rocks with which he deals, and the ability not only to acquire and assimilate the work of other observers, but to show clearly that towards the end attained not only himself but a host of other workers have contributed.

Evidence from apophyses, chilled margins, contact metamorphism, and inclusions, as well as from the ultimate chemical and mineralogical constitution of the rocks, is all effectually used to demonstrate that these rocks are igneous products; the close association of a wide range of petrographic types is evidence pointing to the same conclusion. The pegmatites are studied in detail, and a conclusion arrived at that in this district

segregative and intrusive types are mixed together. This preliminary study is followed up by Prof. Williams' student, Mr. C. R. Keyes, in a detailed description of the binary or true granites, granitites, and hornblende-granites of Maryland. This writer insists that both primary and secondary muscovite occur in the granites, and that the intimate intergrowths of allanite and orthite are original and not secondary products. The bed-like or "sheeted" and spheroidal joints are described and illustrated, and it is made quite clear that the rocks are of igneous origin, locally affected by shearing, so as to pass into gneissose and schistose rocks.

Mr. Lawson's paper on the Geology of the San Francisco Peninsula is deserving of attention at the present time, when cherts and other radiolarian rocks are being so much studied in Britain. Mesozoic rocks, the Franciscan series, rest unconformably on the Montara granite, which, in its turn, is intrusive into crystalline limestone. The Franciscan series consists of sandstones, in the interstital matter of which important reconstruction has occurred, foraminiferal limestones, radiolarian cherts, and volcanic rocks, partly intrusive and partly interbedded, and often exhibiting characters similar to the "pillow lavas" which occur in Britain in association with cherts. The latter rocks, which range from holocrystalline aggregates of quartz granules to masses of isotropic silica, are well banded and associated with what the author calls shales, although "the highest powers of the microscope fail to reveal any clastic material" in them, and he is driven to admit that it is only the interbedding of the cherts with common sandstone which checks the supposition that they are deep-sea deposits. He inclines to the view that the silica has been mainly derived from submarine, siliceous springs. The rocks of this series, where associated with intrusive peridotites, pass into micaceous, chloritic, and amphibolic schists. An excerpt from some notes of Dr. Hinde shows that he has compared the radiolaria with forms from Jurassic and Cretaceous rocks in Switzerland and Hungary. A short account of the serpentines, the later bedded rocks, the diastrophic record, and geomorphy concludes the memoir.

The preliminary report on the Marquette iron-bearing district of Michigan, while illustrating the use of local names in accurately defining particular terranes, certainly makes one wish that such of the terms as are likely to become of larger importance were less cacophonous. The Wewe slate, the Ajibik quartzite, the Bijiki and Kitchi schist, of this paper, the Rappahannock and Aquia Creek series of another paper, suggest a large field of work for the International Congress in the special effort at simplification of nomenclature which it is making at St. Petersburg. The basement series of granites and gneisses is separated by an unconformity from the lower Marquette, and that by another from the upper Marquette series, all these systems being folded together in a complicated fashion which has not yet been unravelled. The two Marquette series are correlated with the upper and lower Huronian systems. The bulk of the iron ores, which consist of specular iron and magnetite, occur in the Negaunee formation of the lower series, and below the Goodrich quartzite; but they frequently extend above and much more often below, into the numerous beds overlapped by quartzite. They have been formed by the concentration of iron ore in a cherty carbonate of iron, governed by the folding of the rocks and the position of intrusive diorite dykes.

Mr. Lester F. Ward contributes a memoir on the Potomac formation to the fifteenth report, and a correlation paper on its analogies to the lower Cretaceous rocks of Europe to the sixteenth report. The general order of succession is studied, and the floras dealt with in detail by the help of tables, plates, and descriptions of new species. The tables lead the author to conclude that the floras compare with the Kome and Atane beds of Greenland, and comprise the interval between these two. The correlation paper is accompanied by beautiful colour-printed geological maps of of South-east England and the Isle of Wight, the author considering that the Potomac formation is about equivalent to the Wealden series. Further comparison is instituted with Cretaceous floras in Italy, and Cretaceous and Jurassic floras in Portugal.

Under Mr. Walcott's direction the publications of the Survey at once become more specialised. One large volume is devoted to purely scientific work, two parts of another to mineral statistics and related papers, and a third to memoirs mainly of an economical character. This has led to a development in the character of the papers. Those of an economic character tend to become more useful to the agriculturist, the miner, and the road-master, while the rest are written in such a way as to be not only of value to the scientific man and popular for the public, but to have an educational character, being evidently written with a view of placing new ideas and methods of work before both official geologists and amateurs. As an example of the latter, we may cite the pre-Cambrian paper, by Mr. Van Hise; of the former, those on road-stones, by Prof. Shaler, and the mining papers in the economic volume.

In dealing with road-metal, Prof. Shaler shows that the tests of crushing strength usually made in Britain and elsewhere, while of great value for building stones, do not express all that is required with regard to material for roads. Bits of stone are placed in a drum, which is overturned at the rate of $33\frac{1}{3}$ revolutions per minute, and the powder is collected and weighed. The binding power of the dust is further tested by making briquettes, which are broken and then crushed, moulded, and broken again as often as necessary. This gives a fair idea of the staying power of any particular stone for different kinds of traffic, and enables the geologist, after further petrographical examination, to express a pretty decisive opinion on the merits of different metalling stones. Study of sections of roads shows that great attention ought to be paid to the gradual building up of metal, and that in many cases it would be advisable to mix softer binding stone with tougher metals on which the steam-roller has little crushing effect. An account of road metals and paving clays in Massachusetts is given in the sixteenth report, and of the United States generally in the fifteenth.

A very valuable report on the Cripple Creek mining district is given by Mr. Whitman Cross and Mr. Penrose, the former dealing with the general geology, the latter with the mining geology. Through a platform of granites and schists a volcano opened in Tertiary times, and ejected at first andesites and then phonolites, basalts, and rhyolites in an order which cannot be precisely ascertained, owing to the removal of lava streams by denudation leaving only dyke rocks behind. A sentence in the introduction shows that scientific terms taken into ordinary use suffer an even worse fate than ordinary terms which have been adopted for scientific use. In England the term granite, and in Ireland diorite, are used as almost synonymous with road-metal, the former being applied to everything from basalts to greywackes, and from porphyroids to hard sandstones. Similarly the word porphyry, originally meaning a purple rock, was first applied to a purple rock with "porphyritic" crystals in it, then to a ground mass like that embedding the crystals, whether the latter were present or not. Now, Mr. Van Hise quotes a miner's definition that "porphyry—well, porphyry generally runs three or four dollars" of gold to the ton.

The phonolites, which are intimately connected with gold deposits, are fully described; they contain abundance of felspar, nepheline, sodalite, ægirine, and a blue

amphibole. Nepheline- and augite-syenite, nepheline-basalt, and tuffs and breccias also occur. The acid and intermediate rocks are rich in alkalies, and the latter eruptions were of strongly-contrasted acid and basic magmas, conforming to the complementary types of Brögger. In the mining portion of the memoir Mr. Penrose shows that gold occurs deep down as a telluride which has been decomposed near the surface to form native gold. The ore deposits occur in fissures, blending into the country rock, and generally associated very definitely with dykes, because fissures have followed pre-existing dykes. Detailed descriptions of the country, with maps and sections, follow.

Mr. Eldridge's geological reconnaissance across Idaho gives a brief description of Archæan and Algonkian rocks, which are overlain by Palæozoic rocks whose exact age is unknown, but apparently ranging from Cambrian upwards, and including sub-Carboniferous rocks. Cainozoic rocks follow, and igneous rocks of all ages from Archæan to Tertiary are present. Several mining districts, yielding gold and silver, are described, and a little coal occurs in the Tertiary rocks.

The Mercur mining district in Utah, described by Mr. Spurr, with an introduction by Mr. S. F. Emmons, yields both gold and silver, the latter chiefly at the contact of limestone with porphyry, where both rocks are altered and decomposed, the former where the Eagle Hill porphyry has produced a silicification of the limestone with which it is in contact. The ores are associated with sulphides, or else have become oxidized near the surface, and the gold probably occurred originally as a telluride.

The economic volume closes with two papers, one on the public lands and their water supply, by Mr. F. H. Newell, and the other on the water resources of the great plains, by Mr. R. Hay. The first paper indicates the rate of progress in disposal of public lands, their general agricultural character, and chief sources of water supply from streams, wells, and reservoirs. The second shows that, although the deep supply of water is limited, quite sufficient for probable requirements may be obtained from the Tertiary grit, which is met with at depths ranging from 100 to over 300 feet.

The two parts of vol. iii. of the Sixteenth Annual Report are entirely devoted to mineral statistics and papers germane to the mining industries. These statistics, previously published as ordinary octavo, are now issued in royal octavo, and form a part of the Annual Report. The production of minerals is represented not only by tables, but by curves and diagrams, so that their meaning can be rapidly grasped, and with them are published not only accounts of the various mining industries of the United States, but notices showing the history and present phase of the same industries all over the world. Mode of occurrence of the various classes of ores, methods of winning them, details of quarrying and mining operations, and prices of products are all treated in detail. Improved methods, whether adopted at home or abroad, are described in full, and every effort is made to bring all the industries abreast, or to keep them ahead, of what is done elsewhere. Many of the papers are compact summaries of particular classes of deposits, which will be extremely useful for those who require to become rapidly acquainted with particular products and industries. As examples of this, the articles on bauxite and fertilisers may be noticed. The article on iron contains a very useful set of maps, showing the localities of iron ore deposits throughout the world. Many of the other articles contain series of analyses, and bibliographies are annexed to some of the papers.

The scientific volume (Part i.) of the Sixteenth Annual Report opens with a short and, to some extent, popular paper on the dinosaurs of North America, by Prof. O. C. Marsh, illustrated by eighty-five plates, indicating the principal structural characters of these reptiles, and giving restorations where they are warranted by the number of bones preserved. The plates were prepared for a series of monographs now in preparation, and they are here published in advance. Questions of classification are relegated to a subordinate position, and the author confines himself almost entirely to a short account of the principal bones found, laying stress on the points which justify the restorations adopted. A useful table showing the horizons of vertebrate fossils in America is given, and in this the beds are classified according to their dominant vertebrate fossils, which, in the Mesozoic rocks, are chiefly reptiles. It is shown that the so-called "bird tracks" of Connecticut River are due to dinosaurian reptiles, and not to birds.

On comparing European with American Sauropoda, Prof. Marsh notes the absence of the gigantic Atlantosauridæ and the Diplodocidæ from Europe, while the Cardiodontidæ are abundant there. Restorations of four European forms—*Compsognathus*, *Scelidosaurus*, *Hypsilophodon*, and *Iguanodon*—are published, and, in conclusion, the affinities and classification of the dinosaurs are discussed.

Prof. H. F. Reid contributes a short memoir on Glacier Bay and its glaciers, like those named after Muir, Rendu, and Cushing, illustrated by an admirable series of photographs and profiles of the ends of the ice streams. After dealing with the "hard" geology, the stratified gravels are considered; these rest on blue clay formed of stream and moraine mud, covered with the tree stumps of a forest which appears to have been living within a few centuries until destroyed by floods and gravel. Certain smooth holes in the ice are thought to be the result of the closing of crevasses containing water by the ice-movement. An esker of sand and gravel, projecting one hundred yards from the moraine of Dent Glacier, has a winding course, and appears to have been produced by a stream flowing in a channel through the ice.

Part i. of the Sixteenth Annual Report closes with three very important papers by Nelson Dale, Van Hise, and Hoskins, dealing with a group of cognate subjects. Mr. Dale gives a series of examples of various structural phenomena which are well illustrated in the Green Mountain region and in eastern New York. Different types of folds, false-bedding, single, double and triple cleavage, and evidences of stretching and brecciation. This short paper is illustrated by drawings and photographs of sections and specimens, many of which are referred to by Van Hise in the communication which follows.

Mr. Van Hise, in his "Principles of North American pre-Cambrian Geology," gives, first of all, a set of principles to guide field-work in these rocks, weaving together the results of his own rich experience with the work of other observers, such as Heim, Lapworth, Rogers, Gilbert, Dana, Geikie, Harker, and a host of others. This is followed by an application of the principles to the different areas where pre-Cambrian rocks may be studied in America.

At a greater depth than 10,000 to 12,000 metres cavities could not exist, even in the strongest rocks, and all fissures and cracks would be closed and welded by flowage of the rock material under the stress existing there. Near the surface deformation of rocks by fracture would be possible, and between the two zones there would exist an area of combined fracture and flowage, the strong rocks yielding by the former, and the weaker by the latter process. Folds are simple or composite if in two dimensions, complex if in three; and it is pointed out that the true succession can only be made out in a complex district by unravelling the cross sets of folds, or, what is the same thing, ascertaining the "pitch" of the axes of the minor folds. The structures hitherto considered under the name of cleavage are separated

into two types; that formed in the zone of flowage at right angles to the stress, and due to the growth of new particles and the orientation of old ones in this direction, thus giving rise to a grain in the rock, receives the name of *cleavage* proper; that which is due to definite planes of parting, formed along surfaces of shear, and originating in the zone of fracture, is called *fissility*. Those rocks, which on coming to the surface from the lower zone pass through the upper while under sufficient pressure to produce fissility, have this structure produced in the planes of true cleavage, while in other rocks it arises independently of any other structures. In deep-lying rocks fissility parallel to the bedding may be produced when the vertical weight is sufficient. Cracking and deposit of minerals may cause banded structures in imitation of bedding, and the imitation may be strengthened by further movement in the banded rock and by metamorphism.

The origin of joints and faults is somewhat lightly discussed. It is shown that both structures may result from pressure or tension, and Daubrée's explanation of joints by torsion is shown to be but another statement of their origin by complex folding. A very important point is made in linking these structures together and showing their relation to fissility, and it is insisted that "there is every gradation between faulting and fissility, and probably every gradation between faulting and cleavage."

Autoclastic rocks, crush-conglomerates and breccias, are next discussed, and it is pointed out how essential it is to discriminate between them and basement conglomerates. Metamorphism, in a wide sense, is next dealt with under the heads of consolidation, welding, cementation, injection, metasomatism, and mashing (dynamic metamorphism). The origin of the chief metamorphic rocks, both sedimentary and igneous, is fully discussed. In dealing with the most ancient sedimentary rocks, unconformities are of the greatest value, in spite of the undeniable difficulty of finding them; other tests of age are dates of intrusion and of movement, and number of movements undergone by different members of a succession. It must here be noted, however, that as the brain of a crow is unable to count more than three men with guns, so the brain of the geologist is inadequate to count more than three directions of movement, if so many. In igneous rocks the order of injection is still to be regarded as the great clue.

The pre-Cambrian rocks are divided into two great groups—the basement complex, or Archæan group, and the pre-Cambrian sediments, or Algonkian group. The different views held as to the origin of the first group are fully and fairly discussed, and after rejection of the theories that they are altered sediments, intrusive rocks, and primitive earth-crust, the view is provisionally adopted that, while little is probably left of the primitive earth-crust on which the Algonkian rocks were formed, it having been destroyed by erosion, the Archæan rocks represent the plutonic rocks solidifying beneath it, their formation in the upper part beginning in Archæan times and continuing steadfastly downwards to the present day. All the intrusions of those later-formed rocks, which have made their way to the surface through the upper (Archæan) layer, must be separated from it and considered as of later date. In dealing with the Algonkian rocks, a useful reference is given to all the fossils hitherto found in these rocks below the *Olenellus* zone, which is taken as the base of the Cambrian. The later part of Mr. Van Hise's paper will be found to be a most useful summary of the present state of knowledge of the American pre-Cambrian rocks.

The appendix to this paper contains a mathematical discussion of the depth of the zone of flowage, and the function of stress and strain on the rocks in producing cleavage and fissility.

NOTES.

THE following despatch from the Government of India t Lord George Hamilton is published in the latest number of the *Kew Bulletin*:—"We are informed by our Director of the Botanical Survey of India that the 'Flora of British India," which was begun by Sir Joseph Hooker some twenty-five years ago, has just been brought by him to completion. The value of the work as a contribution to pure science has already been appreciated and acknowledged by others who are more competent to speak in such a matter than ourselves. But we desire to express our hearty recognition of the service to India which Sir Joseph Hooker has rendered by his monumental undertaking. He has for the first time brought the botany of the Empire into a collective form and placed it upon a firm and lasting basis, thus completing the work which he began nearly half a century ago in the Himalayas. We would ask your lordship to convey to Sir Joseph Hooker our high appreciation of his labours, and of their value and importance as systematising and adding to our knowledge of the vegetable productions of India, and our hearty congratulations upon having brought to a satisfactory conclusion a work to which he has devoted so many years of his life." In transmitting a copy of this letter to Sir Joseph Hooker, Sir Arthur Godley writes:—"Lord George Hamilton desires heartily to associate himself with the Government of India in their acknowledgment of the valuable services you have done to India by this great work, and by your labour in the field of Indian botany, since you first visited that country nearly fifty years ago."

WITH reference to the foregoing note, we learn from the *Kew Bulletin* that Sir J. D. Hooker's literary activity has not ceased with the completion of the "Flora of British India," which has occupied him for a quarter of a century. The veteran botanist has offered to undertake the preparation of the two remaining volumes of the "Handbook to the Flora of Ceylon," left unwritten by the untimely death of Dr. Trimen. The necessary materials and specimens have already been received at Kew from the Royal Botanic Garden, Peradeniya.

THE St. John's correspondent of the *Times* states that Lieut. Peary, the Arctic explorer, has returned from Greenland, bringing the Cape York meteorite, weighing forty-five tons, the largest in the world, and also six Arctic Eskimos, who are going polewards with him next summer. All the members of the expedition are well.

THE Commission du Musée d'Histoire naturelle at Geneva has formed itself into a committee having for its object the erection of a monument to the memory of François Jules Pictet-de la Rive. A site for the monument has been granted in front of the museum. Old students of the eminent investigator, and all who are interested in the work which he accomplished, are invited to send subscriptions for the memorial fund to MM. Lombard, Odier & Cie, Genève.

DR. T. W. ENGELMANN, professor of physiology in the University of Utrecht, has been appointed successor to the late Prof. Du Bois-Reymond in the chair of Physiology at Berlin.

PROF. WIESNER, of Vienna, has undertaken during the past summer a journey to Spitsbergen to complete his observations, previously made in the Tropics, as to the effect of light and other external conditions on the growth of plants.

AN International Ornithological Congress will be opened at Aix on November 9.

IT is reported that earthquake shocks were felt at Tashkent on Saturday last, September 18. The disturbance was noticeable

over the whole of Turkestan, including Kasalinsk, Petrovsk, and Alexandrovsk. At Tashkent, Samarkand, and Ura-tiube several monuments of antiquity were damaged. A shock of earthquake, accompanied by a rumbling sound and the falling of rocks from the mountains, is also reported from the cantons of Grisons and Glarus, Switzerland.—A very severe shock of earthquake was experienced at Lima, Peru, on Monday, September 20. The cornices of churches and houses fell, and the walls were cracked.—At two o'clock on Tuesday afternoon, September 21, two shocks of earthquake were felt at Rome and in other places in Italy, including Rimini, Fermo, Recanati, Bologna, Sinigaglia, Fabriano, Cagli, and Florence. The shocks were also felt at Venice and Trieste.

FROM an obituary notice in the *British Medical Journal* (September 18) we derive the following particulars of the scientific career of the late Dr. A. F. Holmgren, whose death we have already announced:—Holmgren was born at Asen, in Linköpings Stift, on October 22, 1831, so that at his death he was almost sixty-six years of age. He studied at Upsala, and then became a teacher of natural science in a school. He graduated as M.D. in Upsala in 1861, and in the following year was commissioned to spend some years abroad to study physiology as it was taught by the great European masters. He studied under Ludwig at Vienna, and under Brücke, du Bois Reymond, and Helmholtz; while he also visited the schools of Paris, London, and Italy. In 1864 he was elected professor of physiology in Upsala, and built there the first physiological institute in Sweden. His scientific work ranges over a wide field, including his researches on the Negative Variation of the Muscle Current (1862), a similar condition in the active heart (1864); the action of poisons, calabar bean, chloroform, and atropine; the use of the ophthalmometer, and studies in colour sensation. Perhaps his best-known works are those on Retinal Currents. He showed the electrical currents of the retina, and how they are influenced by light, not only white light, but also the action of the various parts of the spectrum. He also showed that the electrical variation caused by light depends upon the retina only, and is not due to changes in the pigment, nor to the action of light on other constituents of the eyeball. His attention was in the early seventies directed to colour blindness, and in 1878 he published his well-known work on "Colour Blindness in relation to Railways and the Navy," thus bringing to a practical issue the work long before begun by George Wilson of Edinburgh (1855). This led him to the invention of his now well-known "worsted test" for colour vision. In 1889 he founded and became the editor of the *Skandanavisches Archiv für Physiologie*, as he says in the preface, "not only to unite our scattered forces under one flag," but to gain a powerful impulse for the advancement of the science in the north of Europe. He elected to publish all papers in German rather than Swedish for obvious reasons. To the last, optical studies were his favourite pursuit, and in 1891-92 we have a long paper in his *Archiv* "On Elementary Colour Sensation." All who were present at the Liège and Berne meetings of the Physiological Congress will remember Holmgren's genial presence, his stately eloquence, and his *bonhomie*. By universal consent he was perennial President of the Congress, and few who saw him two years ago would have thought that he would be so soon removed from his sphere of activity.

THE expectations of the inventor of the *Bazin* roller-boat as to the high rate of speed to be obtained with steamers without increase of engine power, owing to the diminution in frictional resistance of the wheels or rollers on which it was proposed to support the vessels, have not been realised. Accounts of this boat appeared in NATURE some months ago (vol. lv. pp. 109, 379). Since then the machinery has been completed and trials made on the Seine, which have shown that the action of the rollers does not decrease the frictional resistance of the water in the manner anticipated by the inventor, the adherence of the water to the surface of the wheels as they revolve acting as a brake and checking the forward movement of the vessel.

A NEW process for producing artificial diamonds has been experimented on successfully by Dr. Quirino Majorana (*Rendiconti della R. Accademia dei Lincei*). The present method consists fundamentally in heating a piece of carbon by the electric arc, and then submitting it to a violent pressure by means of a small plunger actuated by a piston, on which a pressure of 5000 atmospheres was suddenly developed by explosion. When a sufficiently strong cylinder had been constructed to withstand this enormous pressure, the experiment produced a black mass consisting largely of graphite and amorphous carbon. On employing Berthelot's method to isolate the diamonds if they existed, small microscopic crystals were obtained, mostly black and opaque, but which exhibited all the properties of true diamonds, notably in their manner of burning at a high temperature. The conclusion drawn from these experiments is that pressure and heat are alone sufficient to transform amorphous carbon into the crystalline or diamond form, and that the presence of a metallic solvent, as in Moissan's experiments, is not essential to the transformation.

AN optical device for the intensification of photographic pictures is described by Lord Rayleigh in the *Philosophical Magazine* for September. Photographers often obtain negatives which are so thin that intensification by chemical processes is insufficient to bring out any effective contrast between the transparent and opaque parts. The method devised by Lord Rayleigh is purely a physical one, and it may be described as a means of using a weak negative twice over. It is well known that by placing a feeble transparency upon a sheet of white paper, the picture becomes clearly visible, even though nothing can be seen when the transparency is viewed by holding it up to the light. Through the transparent parts the paper is seen with but little loss of brilliancy, while the opaque parts act, as it were, twice over, once before the light reaches the paper, and once again after reflection on its way to the eye. This is the principle of Lord Rayleigh's method. Instead of the paper, a flat polished reflector is used, the film side of the negative being placed in close contact with it. On the other side of the negative, and fairly close to it, is a condensing lens, which gives parallelism to the rays from the candle used as a source of illumination. The candle is placed just alongside of the copying lens; the light from it passes through the condensing lens, and falls as a parallel beam upon the negative. After reflection, the light again traverses the lens, and forms an image of the candle centred upon the photographic copying lens. An optically intensified positive is thus obtained, and by copying it in the same way in the camera, a negative with more pronounced contrast than the original may be made. To obtain satisfactory results, the false light reflected by the optical surfaces employed must be eliminated. In the case of the condensing lens the difficulty is overcome by giving the lens a slight slope with reference to the face of the negative. The false light reflected from the glass face of the negative to be copied may be got rid of by fixing a wedge-shaped glass plate to the glass side of the negative by means of fluid turpentine.

A DESCRIPTIVE list of mammals obtained from Somaliland by the East African Expedition of the Field Columbian Museum has been prepared by Mr. D. G. Elliot, and is now published in the Zoological Series of the Museum's publications. The expedition was sent to Africa to procure for the Museum specimens of the large wild animals which are rapidly becoming extinct. It appears to have been "uncommonly successful in obtaining ample series of nearly all the species inhabiting the country

it traversed." Grace for the sin of killing animals which ought to be preserved may, perhaps, be found in the remark that "many more examples of the different species could easily have been procured, but after what was considered to be a sufficient number had been secured no more were killed, no matter how often the animals were encountered." The notes upon the characteristics and habits of the animals in life are very interesting.

IN previous numbers we have reproduced records of the Calcutta earthquake-pulsations of last June, obtained by means of the bifilar pendulum at Edinburgh and Cancani's seismometrograph at Rocca di Papa near Rome. Another fine diagram, made by the Vicentini microseismograph at Padua, is given in a paper by Dr. M. Baratta in the *Bollettino* of the Italian Geographical Society. The movement in both components began at 11.17 a.m. (Greenwich mean time), the pendular oscillations soon becoming very great. These lasted until about 11.35, but they were evidently superposed on long slow undulations, for the traces made by the pens are not symmetrical with respect to their normal positions. After 11.40 these undulations, which had a period of about twenty seconds, were isolated, and are unusually well marked, especially between 11.45 and 11.50. They are clearly visible on the diagram until 1·30 p.m., and, with the aid of a lens, for some time afterwards; so that, in consequence of this shock, the ground in Italy must have oscillated for about four hours.

THE kiss in Europe and China is the subject of a short paper by M. Paul d'Enjoy (*Bull. Soc. d'Anthrop.*, 1897, viii. p. 181). Originally, he says, the European kiss was a bite and a suction, the Mongolian being the act of smelling. The whites express to the person embraced that they would eat him or her with great pleasure; the yellows declare that the smell is that of an agreeable prey, either of nutrition or love. Whether from hunger or the sexual appetite, the two kinds of kissing have their origin, according to this author, in the instinct of the preservation of the race.

THE precommercial age, which was a very early stage in human culture, is exemplified at the present day, according to Letourneau (*Bull. Soc. d'Anthrop.*, 1897, viii. p. 152), by the Fuegans and Australians. The Eskimo, owing to contact with Redskins and Europeans, have, like the Veddahs of Ceylon, just passed beyond this stage. The Eskimo of Kamtchatka trade with the Russians, as do the Veddahs with the Cinghalese, by depôts, and avoid all direct communication.

THE lumbar curve of the vertebral column has been studied by Cunningham and by Turner, but very little information concerning this feature among the American races was forthcoming till a recent paper by Dr. G. A. Dorsey in the *Bulletin of the Essex Institute*, Salem, Mass. (vol. xxvii. p. 53). The mean index of eight varied American peoples ranges between 100·3 and 101·5; they are thus orthorachic. Dorsey considers the lumbar index as an important means of determining sex in any individual race or tribe, and that it bids fair to become one of the most valuable ethnic tests known in determining the physical superiority or inferiority of any tribe or race.

WE have received a letter from Mr. Saville-Kent with reference to the short article in NATURE of September 9 (p. 455) on the successful rearing of lobster larvæ by Mr. J. T. Cunningham. Mr. Saville-Kent points out that more than twenty years ago, in 1875, he was fortunate in rearing a number of these crustaceans from the egg to the final or ambulatory stage. A paper embodying the results of his experiments was communicated to the Conferences held in connection with the Great International Fisheries Exhibition in 1883, and it appears with accompanying illustrations in the official publications issued in connection with that Exhibition. We have referred Mr. Saville-Kent's letter, and the paper containing the results of his experiments, to Mr. Cunningham, who writes:—"I very much regret that in forwarding to you the facts concerning my experiments in lobster rearing at Falmouth, I overlooked Mr. Saville-Kent's previous success in the same practical problem. Although I had a vague recollection of having heard that he had made experiments of this kind, I had never seen any description of them, and I certainly did not think that he had succeeded in rearing the larvæ through the whole of their metamorphosis. Mr. Saville-Kent's paper, which I have now had the pleasure of seeing for the first time, was not in the library of the Plymouth Laboratory, at least I never saw it there, although I was fairly familiar with the contents of that library."

FROM the *Proceedings of the Chemical and Metallurgical Society of South Africa* for July last, it appears that, after many fruitless attempts, the treatment of stamp battery slimes from gold ores has now been mastered, and is steadily going on in several works in South Africa. Formerly the excessively finely crushed portion of the battery tailings, amounting to some 30 per cent. of the whole, was perforce allowed to run to waste, though theoretically worth nearly 1*l.* per ton. The slimes are now agglomerated and precipitated from the water in which they are suspended by the addition of lime water, and are then treated by agitation with very dilute solutions of cyanide (containing 0·01 per cent. or less of available KCy), and washed by settling and decantation, the gold being deposited by electrolytic action under the Siemens-Halske system. This process has been running for over twelve months at the Crown Reef Works, and is now costing about 3*s.* 9*d.* per ton, including royalty and management. The extraction is 83 per cent., and the net profit about 10*s.* per ton, or 50*l.* per day. The freshly-formed slimes in course of treatment at these works yield their gold to cyanide readily enough; but it is otherwise with accumulated slimes, in which oxidation of the pyrites has taken place. Here the presence of finely-divided ferrous sulphide and hydrate absolutely prevents the dissolution of the gold by withdrawing the free oxygen from the solution. Mr. W. Caldecott has discovered that by the supply of oxygen artificially this difficulty is cheaply and effectively overcome, and that jets of air, moreover, form the best means of agitation. Potassium permanganate is also used as an oxidiser. The oxidation and destruction of cyanide by air, long regarded as preventing its use for agitating cyanide solutions and promoting their solvent action, is not excessive in presence of ferrous sulphide, when the solution contains only from 0·005 to 0·008 per cent. of cyanide, or about 2 ounces per ton, an amount which, small as it is, is enough for the solution of the gold.

AN account of the range, cultivation, uses and products of the Camphor tree (*Cinnamomum camphora*) is given in a circular (No. 12) just distributed by the U.S. Department of Agriculture (Division of Botany). Notwithstanding the comparatively narrow limits of its natural environment, the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalised in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in south-eastern France, and in the San Joaquin Valley in California, where the summers are hot and dry. Large trees, at least two hundred years old, are growing in the temple courts at Tokyo, where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12° to 16° F. The conditions for really successful cultivation appear to be a minimum winter temperature not below 20° F., 50 inches or more of rain during the warm growing season, and an abundance of plant food, rich in nitrogen. In the native forests in Formosa, Fukien, and Japan

camphor is distilled almost exclusively from the wood of the trunks, roots, and larger branches. The work is performed by hand labour, and the methods employed seem rather crude. The camphor trees are felled, and the trunk, larger limbs, and sometimes the roots, are cut into chips, which are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering towards the top like an old-fashioned churn. The tub has a tight-fitting cover, which may be removed to put in the chips. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs out of a hole in one side. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallises, while the oil drips down and collects on the surface of the water. In some cases the camphor and oil are allowed to collect together on the surface of the water, and are afterwards separated by filtration through rice straw or by pressure. About twelve hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time the camphor and oil are removed from the condenser. By this method 20 to 40 pounds of chips are required for one pound of crude camphor.

DR. WILHELM HALBFASS contributes to *Petermann's Mittheilungen* the results of observations on eight of the Eifelmaare. Elaborate contour maps are given, and a series of records of temperature and transparency. All the lakes are practically circular, the bottom steepest near the edges. The Laachen See is by far the largest, while the Pulver-Maar is the deepest lake in Germany outside the Alps, attaining a depth of 74 metres.

A PHENOLOGICAL map of parts of the coast regions of Albania and Epirus, by Dr. A. Baldacci, of Bologna, appears in *Petermann's Mittheilungen* (vol. xliii. 7), with part of a paper by the same author describing the physical geography and climate of the district in relation to its flora. The special interest of the region lies in the transition from the Mediterranean to the Alpine-Arctic flora direct, without the necessary interposition of the usual coniferous belt.

DR. A. PHILIPPSON publishes in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* a short account of a cruise amongst the Greek islands of the Ægean during 1896. A number of geological observations were made, and are plotted on a sketch map, forming a distinct contribution to our meagre knowledge of this interesting region. The distribution of the masses of crystalline rock and the arrangement of the lines of faulting, call for thorough exploration.

Two important contributions to the literature of historical geography have recently been published in Germany. The *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (vol. xxxii. No. 2) contains a paper, by Dr. Konrad Kretschmer, on a Catalan map in the Biblioteca Estense at Modena of date 1375, with a reduced facsimile of the map appended. These Spanish maps are of the greatest interest to geographers, particularly on account of the commercial relations existing at that time between Italy and southern France and north-eastern Spain. Only fourteen have hitherto been known, and of these only three are accessible in facsimile: that here reproduced and elaborately discussed by Dr. Kretschmer forms the fifteenth, and is the first known Catalan circular map of the world. Nos. 5 and 6 of the present volume of the *Mittheilungen der k. k. Geographischen Gesellschaft* of Vienna contain an abstract of a Festschrift published in commemoration of the opening of the sea route to India by Vasco de Gama, being a translation of parts of the Mohît of the Turkish admiral, Seidî 'Ali, with reproductions of some of the maps. The translation is by Dr. Maxim Bittner, Privat-docent in Oriental languages in the University of Vienna, and there is an introduction by Prof. Tomaschek. The Mohît is practically a book of sailing directions compiled, by the best sailor Turkey ever had, about the year 1554. Two chapters and part of a third dealing with topographical matters were translated by Prof. Luigi Bonelli and published in 1894; and the present paper covers much the same ground, with improvements and additions derived from the one of the two existing manuscripts which is deposited in Vienna. Translations of other parts of the Mohît into English, by Joseph Baron von Hammer-Purgstall, were published in the *Journal of the Asiatic Society of Bengal* between the years 1834-38.

THE College of Agriculture at Tokyo is doing excellent experimental work, judging by the contents of the latest *Bulletins* it has issued. In that of June last are several interesting memoirs, amongst which we may mention "Contributions to the Chemistry of Saké Brewing," by J. Okumura, in which attention is directed to the loss of starch which takes place in the process of washing the rice before it is steamed for saké brewing, whilst some valuable observations are recorded on the enzyme of the *Koji* fungus (*Aspergillus oryzæ*). K. Yabe contributes a paper on the origin of the saké-yeast, in which he points out once more that the *Aspergillus oryzæ* is quite incapable of yielding the saké-yeast cells. K. Negami details the results of his experiments on the fermentation of a grape wine with the saké-yeast cells, which do not, however, encourage the use of the latter for this purpose, the taste of the fermented product being that of an average white wine, the *bouquet* being, moreover, of an inferior quality. A highly suggestive memoir, full of experimental observations, is contributed by U. Suzuki, entitled "On an important function of leaves." The author comes to the conclusion, as the result of his investigations, that reserve proteids in the leaves are decomposed into amido-compounds during the night, and the latter are transported from the leaves to the other parts of the plants. The leaves facilitate the formation of proteids in all parts of the plants by the assimilation of nitrates, yielding thereby amido-compounds. A great advantage is thus gained for the stems, roots and fruits, in which the conditions for nitrate assimilation are less favourable than in the leaves. The May *Bulletin* of the College is entirely devoted to a long memoir, by H. Tokishige, "On the nature of Japanese Farcy, an Enzootic Skin Disease of the Horses and Cattle of Japan."

INVESTIGATIONS carried out at the Purdue University Agricultural Experiment Station in 1895, demonstrated that an efficient preventive of potato scab (a parasitic disease) is obtained by treating the seed tubers with corrosive sublimate. The poisonous and corrosive nature of this compound renders the treatment objectionable to some extent, so investigations have been made with the idea of discovering a preventive having the good qualities of corrosive sublimate without its bad ones, and which could confidently be used as the standard fungicide for potato scab. According to a bulletin just received from the Agricultural Experiment Station referred to above, this substance is formalin, the germicidal action of which was discovered by Loew in 1888. Observations made at the station lead to the following conclusions:—Formalin, a non-poisonous, non-corrosive substance, will practically free seed potatoes from scab germs by an immersion for two hours in a solution of the approximate strength of 1 : 300. It is equal to corrosive sublimate in efficiency, and is without its dangerous and troublesome properties. Seed material of seemingly good quality, as well as that much affected

with scab, shows beneficial results from treatment. The recipe for its use is to add eight fluid ounces (about one half-pint) of formalin to fifteen gallons of water, and soak the seed tubers in it for two hours before planting. This solution may be used several times.

A FOURTH edition of the skeleton guide to the Royal Gardens, Kew, is now on sale at the Gardens. It has been carefully revised so as to include all recent improvements, and the size has been somewhat reduced to make it more convenient for the pocket.

A BATCH of the *Bulletins of Miscellaneous Information* of the Royal Gardens, Kew, Nos. 122-129, just received, contains many articles of scientific and practical interest. Under the name *Rhizopus necans* sp.n., Mr. G. Massee describes and figures a parasitic fungus exceedingly destructive to lily bulbs in Japan. It appears, however, not to attack uninjured bulbs, but gains an entrance only through wounds, more especially through broken roots. Attention is called to the importance of the cultivation in India of the papaw-tree, *Carica papaya*, from the value of the papain or "vegetable pepsin," which abounds in the unripe fruit. An interesting feature of the work done at Kew has been a compilation of the cryptogamic flora of the Gardens. Mr. G. Massee has been entrusted with the mycological department of the work, and now contributes a list of the fungi collected in the Gardens, numbering 337 genera and 1340 species, probably far surpassing in point of numbers, as well as in the variety of rare and interesting species, the mycological flora of any other area of equal size. The remarkable fact, however, is mentioned that not a single species of parasitic fungus that has proved destructive to plants, has been introduced to Europe through Kew. A list of the "Myxogastres" is also appended. From some notes contributed by the Director, it would appear that all questions respecting the botanical origin of myrrh are not yet settled, especially with regard to Somali myrrh; and travellers in that country are urged to bring home specimens of the tree from which it is obtained. At the instance of the Government of the Gold Coast, an investigation has been undertaken by Mr. W. H. F. Blandford of the insects destructive to cultivated plants in West Africa. The correspondence is now published which gives the results of this inquiry, and the suggested remedies. An interesting note is reprinted from the *Hawaiian Planter's Monthly*, by Mr. H. M. Whitney, regarding the grafting of the sugar-cane, and the possible production of a graft-hybrid. In the *Diagnoses Africanæ*, No. x., are contained descriptions of some of the novelties included in several important collections recently received at Kew: viz. that of Dr. Forsyth Major from Central Madagascar; that of Mr. G. L. Bates from the Cameroons region; and that of Mr. Alexander Whyte from North Nyasaland, a country which had never previously been explored botanically. Among other subjects referred to in these numbers are the West India sugar-trade, fruit-growing at the Cape, and the use of *Eucalyptus* timber for wood-paving.

THE periodical entitled the *Archives of Skiagraphy* has become the *Archives of the Röntgen Ray*, edited by Dr. W. S. Hedley and Mr. Sydney Rowland, and published by the Rebman Publishing Company. It is chiefly as a pictorial record of applications of Röntgen photography to surgery that the periodical has found a professional public. This feature will be continued as heretofore, and, in addition, a certain amount of useful letterpress upon methods of work and progress of investigation will be included. The publication will thus not merely deal with the practical usefulness of the new radiation, but also with its scientific bearings. The number before us contains articles upon the nature of the Röntgen Rays, by Prof. S. P. Thompson, F.R.S.; Röntgen Rays, past and present, by Dr. W. S. Hedley; and a number of notes, mostly cuttings from the daily papers. All the subjects of the Röntgen photographs reproduced are of purely medical and surgical interest.

THE fourth edition of "Quantitative Chemical Analysis," by Prof. Frank Clowes and J. Bernard Coleman, has been published by Messrs. J. and A. Churchill. The book has not been modified to any considerable extent, but descriptions of a number of new methods and apparatus have been added.—Mr. Edward Stanford has issued a fourth revised edition of "Epping Forest," by Mr. Edward North Buxton. This excellent little book is not only an interesting guide to all the beauties of Epping Forest, but also a brightly-written handbook of local natural history. Chapters have been added on forest management, the geology of the district, pre-historic man and the ancient fauna, and the entomology, pond-life, and fungi of the forest. There are six large coloured maps, and many illustrations in the text. —A fourth edition of an illustrated handbook of instruction in methods of saving persons from drowning, has been published by the Life Saving Society. The book contains, in addition to a course of instruction in rescue from drowning, descriptions of the methods adopted in resuscitating the apparently drowned, and a short account of the principles underlying them.

THE following are among the papers and other publications which have come under our notice within the past few days:—An eulogy of the late Prof. Alfred M. Mayer, accompanied by a full-page portrait of the lamented investigator, is contributed to *Science* (August 20) by Prof. Le Conte Stevens.—An address on the connection between pharmacy and science, delivered by Prof. E. Shaer at the recent meeting of the German Apotheker-verein, appears in the *Pharmaceutical Journal* (September 18).—A paper containing the results of studies of Mexican and Central American plants, by Dr. J. N. Rose, has been published in the *Contributions* from the U.S. National Herbarium (vol. v. No. 3).—Dr. James Murie writes upon "Our Economic Sea Fishes," in the *Zoologist* (September 15), and describes a few of the results of the study of the life-history of our food-fishes during the past twenty years or so.—The eighth and ninth numbers of Dr. George King's "Materials for a Flora of the Malayan Peninsula," reprinted from the *Journal* of the Asiatic Society of Bengal, have just been distributed. In No. 9 the account of the Calycifloræ is begun. This contribution covers 345 pages, and Dr. King hopes "that one more contribution similar in size to the present one will suffice to complete the account of the Calycifloræ, and so to bring the whole series about half-way towards completion."—Vols. x., xi. and xii. of the *Annalen* of the Imperial University Observatory at Vienna, edited by Prof. Edmund Weiss, have been received. The contents include position observations of planets, comets and nebulæ, made with the various instruments at the Observatory from 1890 to 1893; observations with the meridian circle, zone observations with the $11\frac{3}{4}$-inch Clark's refractor, and meteorological observations.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂) from South Africa, presented by the Earl of Orkney; a Coypu (*Myopotamus coypus*) from South America, presented by Mr. H. W. Garratt; an Arctic Fox (*Canis lagopus*) from the Arctic Regions, presented by Mr. G. B. Collier; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. Harold Smith; a Water Vole (*Arvicola amphibius*) from Scotland, presented by Master E. Hope Vere; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, presented by Mr. Charles Strong; two Grey-breasted Parrakeets (*Myopsittacus monachus*) from the Argentina, presented by Mr. R. M. Copnall; two Gannets (*Sula bassana*) from Scotland, presented by the Hon. Walter Rothschild; a Marabou Stork (*Leptoptilus crumeniferus*) from

British Central Africa, presented by Captain C. F. Beeching; a Raven (*Corvus corax*) British, presented by the Rev. F. C. A. Barrett; a European Pond Tortoise (*Emys orbicularis*), European, presented by Miss W. Fenwick; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, a Burchell's Zebra (*Equus burchelli*), born in the Menagerie, deposited; two Red Foxes (*Canis fulvus*) from Canada, a Black Woodpecker (*Picus martius*), a Hoopoe (*Upupa epops*), four Little Ringed Plovers (*Ægialitis curonica*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE CAUSE OF THE PROPER MOTIONS OF STARS.—When the parallax of the star 1830 Groombridge is considered in connection with the large proper motion of seven seconds of arc per annum, the conclusion is arrived at that the star is moving through space with a velocity which probably exceeds two hundred miles per second. In his "Popular Astronomy," Prof. Simon Newcomb briefly discussed the problem of stellar dynamics involved in this enormous velocity. He showed that if the universe be considered of such an extent that light would take 30,000 years to cross it, and if it contained one hundred million stars, having, on the average, a mass five times the mass of the sun, the gravitational attraction of a universe thus constituted would only be sufficient to give a velocity of twenty-five miles per second to a body drawn from infinity to the centre of the system of masses. The calculated limit is thus only about one-eighth the velocity deduced from the observed proper motion and parallax. Prof. Newcomb therefore concluded: "Either the bodies which compose our universe are vastly more massive and numerous than telescopic examination seems to indicate, or 1830 Groombridge is a runaway star, flying on a boundless course through infinite space with such momentum that the attraction of all the bodies of the universe can never stop it."

A new contribution to this inquiry was read recently before the American Philosophical Society by Mr. Luigi d'Auria. The object of the investigation was to determine whether, assuming the interstellar ether to possess the virtue of gravitational attraction, the force exerted by it would be sufficient to account for the proper motions of stars, and especially of the flying star 1830 Groombridge. In this paper it is shown that, "given the ether the density as estimated by Maxwell, and the power of attracting matter by gravity, a body placed within the sphere of ether containing all the stars of the visible universe, and at a distance from the centre of such sphere equal to that passed over by light in 2200 years, would pass this centre with a velocity equal to that of the star 1830 Groombridge, taking into account the attraction of the ether alone; and such body would oscillate about the same centre, rectilinearly, with a period of a little over *seven million* years, which would be also the period of oscillation of every other star." Mr. d'Auria recognises that some other, and unquestionable, cause may eventually prove to be responsible for stellar proper motions, nevertheless he thinks his results are worth putting on record.

NEW DETERMINATION OF THE SOLAR CONSTANT.—A fresh contribution to our knowledge respecting the sun's heat appears in the *Memorie della Società degli Spettroscopisti Italiani*, vol. xxvi., 1897, where Dr. G. B. Rizzo describes a series of observations for determining the solar constant, made at the station "Regina Margherita" on Monte Rosa. The apparatus used was a slight modification of Ångström and Chwolson's; the sun's rays being received on two brass discs attached to thermometers, which were alternately exposed and protected by two aluminium screens so arranged that when one disc was covered the other was exposed. To determine the quantity of solar heat absorbed per unit area per unit time, the formula of Chwolson was employed. Owing to the unsettled weather in September last, when the observations were made, the results were found at times to fluctuate considerably. In determining the solar constant or quantity of heat (measured in calories per minute) incident normally on a square centimetre at the earth's distance from the sun, it is necessary to assume some law for the effect of atmospheric absorption at the place of observation. Dr. Rizzo finds that the formulæ of Forbes and Crova for this purpose, when applied to his present observations, give for the solar constant the respective values 3·133 and 4·934. Both these values are somewhat in excess of the average of previous observations, but the divergence between them renders further investigation desirable.

THE DIAMETERS OF JUPITER AND HIS SATELLITES.—Herr Leo Brenner communicates to the *Astronomische Nachrichten* (No. 3444) the results of recent measures, made by him at the Manora Observatory, of the widths of the various bands and belts on Jupiter, and the angular diameters of the planet and its four large satellites. The following are the results of the measurements of diameters, reduced to mean distance:—

	Equatorial diameter.	Polar diameter.	Oblateness.
Jupiter	$38''\cdot539$	$36''\cdot134$	1 : 16·024
Satellite I.		1·060	
Satellite II. ...	1·063	0·958	1 : 10·123
Satellite III. ...	1·704	1·504	1 : 8·52
Satellite IV. ...	1·550	1·345	1 : 7·568

ACTION OF JUPITER AND SATURN UPON ENCKE'S COMET.—In a memoir which will shortly appear, M. A. Lebeuf gives formulæ for calculating secular inequalities when the mutual inclinations of orbits, and the eccentricity of the orbit of the disturbed body, are known. The formulæ are applied by M. Lebeuf, in the *Bulletin Astronomique*, to determine the secular inequalities of the elements of the orbit of Encke's comet in consequence of the action of Jupiter and Saturn. The values obtained are tabulated below:—

Elements of orbit.	Secular inequality due to Jupiter.	Secular inequality due to Saturn.	Simultaneous action of Jupiter and Saturn.
$\frac{de}{dt}$	$+ 1''\cdot38$	$+ 0''\cdot2$	$+ 1''\cdot40$
$\frac{di}{dt}$	− 25·6	− 0·45	− 26·1
$\frac{d\Omega}{dt}$	− 35·9	− 0·85	− 36·8
$\frac{d\omega}{dt}$	+ 28·3	+ 0·66	+ 29·0
$\frac{d\epsilon}{dt}$	− 133 6	− 3·04	− 136·6

It is pointed out that the large eccentricity of Encke's comet, and the small distance of the comet from Jupiter, makes the use of the formulæ difficult in the case of Jupiter; but the results seem to justify their application to the case of Saturn.

PHASE-CHANGE OF LIGHT ON REFLECTION AT A SILVER SURFACE.

A LIGHT wave, when reflected[1] at the surface of separation of two media, may be altered in amplitude, or wave-length, or phase. Whilst, however, a change of amplitude or wave-length produces an obvious difference between the incident and reflected light, the existence and nature of a change of phase can only in general be inferred from the result of some kind of interference experiment. Thus the fact that a very thin transparent film is black when viewed by reflected light leads to the conclusion that a light wave is altered in phase by half a wave-length on reflection, either at a denser or at a rarer medium. Mechanical analogies suggest that the change probably takes place at the denser medium; and an experiment of Lloyd's, in which coloured fringes with a black centre were obtained by the interference of two beams of light, one directly transmitted, and the other reflected from a glass mirror, led to the same conclusion.

Jamin's experiments on metallic reflection showed that when light is reflected from a silver surface a phase-change is produced, and, moreover, that this change is different according as the light is polarised in, or perpendicular to, the plane of incidence. His experiments led to the determination of the

[1] The term "reflection" is here used in its most general sense, to include such phenomena as phosphorescence, &c.

difference between the phase-changes in these two cases, but gave no direct information as to the absolute magnitude of either.

By depositing a wedge-shaped silver film on the outside of one of the thick glass mirrors of a Jamin refractometer, and observing the interference bands where they crossed from the glass-air to the glass-silver surface, Quincke concluded that the phase-change, when light is reflected in glass from a silver surface, depends on the thickness of the silver, but was unable to decide whether it was a quarter-wave acceleration or three-quarters of a wave retardation for a thick silver film. The reason of his uncertainty will be explained later. Wernicke and Wiener analysed spectroscopically the light reflected from thin transparent plates, the back surfaces of which were partly silvered. The spectra obtained were crossed with black bands, depending in number and breadth on the thickness of the plate; and these bands were displaced where the light was reflected from the silver surface. Wernicke, however, concluded that the phase-change amounted to a quarter-wave acceleration, whilst Wiener concluded that it was of the nature of a retardation of three-quarters of a wave-length. Wernicke has since stated that silver films could be obtained which would produce either of these phase-changes, according to the nature of the film.

A modification of Michelson's refractometer may be advantageously used to study this vexed question. Light from a lamp L, placed at the principal focus of a lens M, falls on the thinly-silvered mirror A, part being reflected along the path

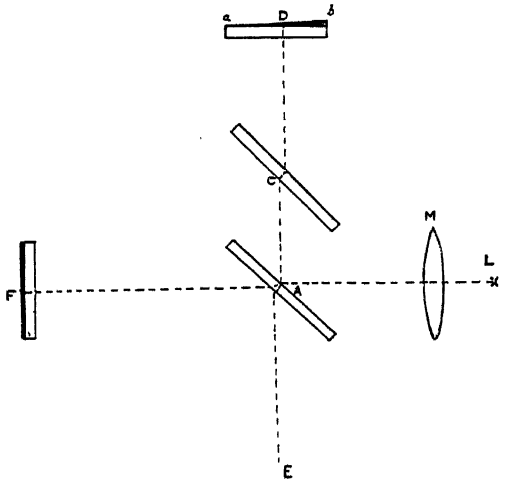


Fig. 1.

A C D, and after reflection from the back surface of D, pursuing the path D C A E, to the eye of the observer. The light originally transmitted through the mirror A pursues the path A F A E. If the two paths are equalised, brilliant interference bands are produced.[2] It will be noticed that these bands are virtually formed by the reflection of light at an air film, comprised between D and the image of F in A. Consequently both they and the surface of D can generally be focussed simultaneously.

Both D and F are silvered on their back surfaces; the film on F is uniform, whilst that on D increases in thickness from one side to the other, as indicated (with exaggeration) by the black line $a\ b$ (Fig. 1). A horizontal strip of glass is also left unsilvered across the middle of D.

The method of obtaining the silver wedge was as follows. The glass was first well cleaned with strong nitric acid, using a small mop made of cotton wool plugged into the end of a glass tube. An ordinary elastic band was then stretched round the plate, and the whole was placed, inclined at an angle of about 30°, in a beaker, and distilled water poured in till it reached the height of the top of the glass plate. A glass syphon tube, reaching to the bottom of the beaker, was introduced, the flow being capable of regulation by a stop-cock on the outer limb. Silvering solution was then quickly poured in through a funnel reaching to the bottom of the beaker. The water was simply displaced upwards, and a few minutes after the silvering solution had reached the level of the top of the plate the stop-cock of the syphon was cautiously opened, so as to slowly withdraw the silvering solution. The flow should at first be moderately quick, but should decrease later. Silver films will be found deposited on both sides of the glass, that on the under side being the better; the film deposited downwards is generally very milky in appearance, and is frequently spotted. If the glass is not washed with nitric acid after the elastic band is placed round it, the silver will be found to gradually shade off towards the clear glass.

The following silvering solution may prove useful to those who wish to make half-silvered mirrors; it was used to form the silver wedges on account of the slowness of its action.

Take silver nitrate 1 gr., dissolved in 20 c.c. of distilled water. Add strong ammonia (·88), drop by drop, till the precipitate formed is just re-dissolved. Add a solution of 1·5 gr. caustic potash (ordinary stick potash works well), dissolved in 40 c.c. of water; then ammonia, drop by drop, till precipitate is just re-dissolved. Add 80 c.c. distilled water, and then a solution of silver nitrate (strength unimportant), till a permanent precipitate is just formed. Make the solution up to 300 c.c. 1·8 grs. milk sugar are dissolved with heating in 20 c.c. distilled water. This solution is added to the above just before silvering is to commence; after a few minutes the whole will commence to

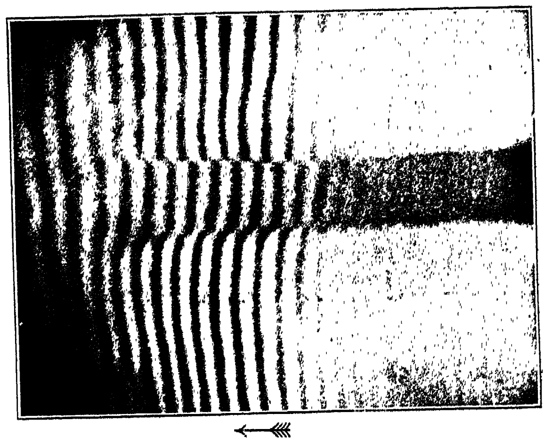


Fig. 2.—The thin edge of the wedge is to the left. A displacement of the bands in the direction of the arrow is produced by lengthening the path A C D (Fig. 1).

blacken. The glass to be silvered may be placed horizontally in an ordinary evaporating basin, and the solution poured in till it reaches the upper surface of the glass. The silver is deposited upwards. For half-silvering about ten minutes is required, when the temperature is about 15° C. For thick silvering the plate should be left at least an hour; we have frequently left it all night with good results. The thick silver film produced may be scrubbed with cotton wool under running water, and finally left for some time in distilled water, when it may be removed and left to dry.

The above recipe for silvering was given to us some years ago by Prof. Boys. It was originally due, we believe, to Prof. Liveing.

Fig. 2 is taken from a photograph of the bands produced, using yellow light (the light from an electric arc passed through a cell, made of signal green glass, filled with a saturated solution of bichromate of potash) and a Cadett plate; exposure, one minute.

The dark band across the figure represents the strip of clear glass on which silver was not deposited. The bands, in passing from the glass-air to the glass-silver surface are seen to be displaced towards the thin edge of the wedge-shaped film, and it is at once seen that the displacement depends on the thickness of the film. In order to produce a displacement of the bands in the same direction, the length of the path A D must be increased. This, according to Wiener, would indicate that the light was retarded on reflection from thick silver by three-quarters of a wave-length. It will be noticed that the bands are continuous, passing from the glass-air to the glass-silver surface. This is

[2] For a simple method of constructing this apparatus, see Nature, August 17, 1893, "Apparatus illustrating Michelson's method of obtaining interference bands." Following Michelson, it was there stated that the central band is always black. We have since determined that the colour of the central band will vary according to the phase-changes produced at the various silver surfaces. We have been able to obtain a white central band.

due to the fact that the silver gradually shades off towards the clear glass. Occasionally, however, each band, in passing from the glass-air to the glass-silver surface, is joined to *both* the nearest bands on the silver. It was due to this cause that Quincke was unable to say whether an acceleration or retardation was produced.

Wernicke states that a retardation is only produced when the silver is of a friable nature, and could be readily rubbed off the glass. The accompanying photograph was obtained with a silver film that easily bore polishing, and showed no want of adherence to the glass.

E. EDSER.
H. STANSFIELD.

MICRO-STRUCTURE OF ALLOYS.

AT the Royal Society's conversazione this year, Mr. J. E. Stead exhibited a series of photographs illustrating the micro-structure of various alloys. In many cases the structure portrayed was very complex and interesting, and in some cases beautiful.

Many series were illustrated by Mr. Stead, but it would take much more space than is available in a short notice to more than point out briefly the main features of a few.

The photographs showed that when the antimony exceeded 7·5 per cent. in antimony-tin alloys, the excess over that amount separated out with an equal atomic proportion of tin as more or less perfectly formed cubes. That they were crystals of definite chemical atomic composition Mr. Stead had verified by several careful analyses after having dissolved away the eutectic, or what was once the mother liquor, with nitric acid, which left the crystals intact. The photographs of alloys of tin containing phosphorus and arsenic had the appearance of very straight bright lines, which cut up the surface into irregular figures. These lines are the edges of flat plates, which, when separated by dissolving away the tin, have been proved by analysis to have the composition of Sn_3P_2 and Sn_3As_2, respectively. The photographs of the separated compounds indicate that they had both the same crystalline form of hexagonal plates. A photograph of one of the free ends of a plate showed several pointed crystals having angles of 60°.

The structure of tin-copper alloys rich in tin was illustrated by several photographs, which showed that in alloys containing from 2 to 0·10 per cent. copper acicular crystals were present, and that with each addition of copper the separated compound assumed a more plate-like structure, until when 35 per cent. copper was present, apparently it was all in the form of plates. All these compounds have been separated and analysed by Mr. Stead, with the following results:—

Alloy.				Crystals separated. Copper.	Tin.	
98·0 °/₀ tin,	2·0 °/₀ copper		...	34·58 °/₀	65·42 °/₀	SnCu (approximate.)
97·0 ,,	3·0	,,	...	36·50 ,,	63·50 ,,	
95·0 ,,	5·0	,,	...	39·80 ,,	60·20 ,,	
90·0 ,,	10·0	,,	...	44·60 ,,	55·40 ,,	Sn_2Cu_3 ,,
85·0 ,,	15·0	,,	...	47·20 ,,	52·80 ,,	
80·0 ,,	20·0	,,	...	53·00 ,,	47·00 ,,	
65·3 ,,	34·7	,,	...	56·12 ,,	43·88 ,,	$SnCu_2$,,

It will be seen that although the compound separated from the 2 per cent. alloys approximates to the composition of SnCu, each addition of copper to the alloy results in the formation of a compound which after separation proves to contain a greater proportion of copper than that from the alloy containing less copper.

It has not yet been proved whether these compounds are amorphous mixtures or combinations of one or more atomic chemical constituents.

It appears that in all the solid alloys of lead and antimony the elements are in a free state. There is a eutectic which contains 12·7 per cent. antimony. Those having more than that quantity of antimony contain large crystals of free antimony, which until 50 per cent. is present are found at the upper part of the alloy if the cooling of the liquid alloy has been sufficiently slow, but between these crystals the eutectic is clearly visible. When the antimony is increased to 50 per cent. the white crystals and dark eutectic occupy nearly equal areas, and with each addition of antimony the dark areas diminish until when 100 per cent. is present the surface presents a homogeneous white appearance free from the dark eutectic.

With alloys containing less than 12·7 per cent. antimony the polished and etched surfaces clearly show the presence of dendritic crystals of lead.

The eutectic has the very peculiar structure similar to that of nodular radiated pyrites. On treating this compound with dilute nitric acid for a long period, a coherent dark-coloured mass is left free from lead, and which appears to consist when broken up as very fine bright plates, exceedingly thin and easily broken up, with the slightest pressure, into what appears to be an amorphous powder.

FIG. 1.—× 30.
Sn, 75 per cent.; Sb, 20 per cent.; As, 5 per cent.

Mr. Stead and Mr. Charpy have simultaneously investigated the alloys of tin-antimony, tin-copper, and lead-antimony, and the results of their micro-examinations are almost identical; but Mr. Stead has supplemented his micro-research with chemical examination, which greatly increases their value.

The micro-structures of ternary alloys are of very much greater interest than those of two metals only, for Mr. Stead

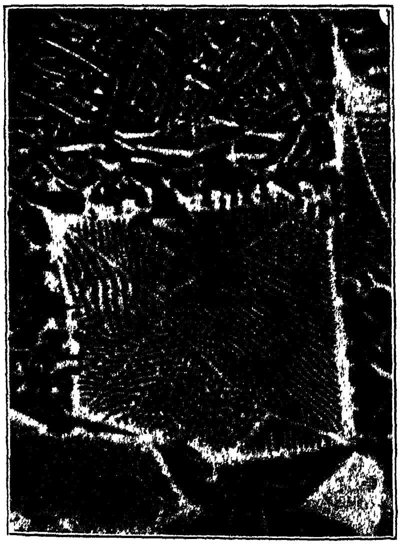


FIG. 2.—Magnolia metal. Magnified 200 diameters.
Pb, 80 per cent.; Sb, 15 per cent.; Sn, 5 per cent.

has shown that it is possible to detect two, and sometime three, distinctly different compounds in the same microscopic field. Sometimes two of the elements combine and crystallise together; sometimes three will so unite. Examples of tin-copper-antimony, and tin-antimony-arsenic (Fig. 1), and lead-antimony-tin (Fig. 2), and tin-antimony-phosphorus were shown at the Royal Society.

The photographs show that in the tin-antimony-copper (tin being in large excess) the copper-tin in the form of needles or plates crystallises out quite separately and independently of the antimony-tin compound which exist as cubes, and both occur side by side in the same alloy. A similar thing occurs with the tin-antimony-phosphorus alloys, the plates of phosphide of tin, and the cubes of antimonide of tin being clearly separate. The eutectic of magnolia metal (lead 80 per cent., antimony 15 per cent., and tin 5 per cent.), under high magnification presents a very beautiful structure, quite different from that of lead and antimony alone, and the fine delicate structure (Fig. 2) apparently consists of crystallites of the cubic system, and these possibly are a combination of the three metals present.

The structures of the tin-antimony-arsenic alloys are very remarkable, and evidently the crystals formed consist of what might be called tin-antimony-arsenides, for they all crystallise together in a fusible eutectic. The alloy, containing tin 75 per cent., antimony 20 per cent., arsenic 5 per cent., presents a most interesting appearance (Fig. 1); the sections of the white crystals are of more or less perfect circular form, and in the solid alloy they exist as spheres, the fractured surfaces proving this to be the case.

Micro-metallography is a comparatively new science, the borders only of which have been but slightly studied, but it promises to give results of the highest scientific interest.

MECHANICS AT THE BRITISH ASSOCIATION.

PERHAPS the most noteworthy feature in the work of this section (G) was the prominence of the Canadian and American papers, apart from the interesting and suggestive address of the President on the education of engineers of the present day; but little of interest was contributed by the English members who attended the meeting. Many members, who in past years have done so much for the section, were unable to be absent from their professional duties for so long a time as attendance at Toronto necessarily involved.

The first paper after the President's address to the section was one by Mr. T. Munro, a Canadian engineer, describing the great works the Canadian Government are constructing to secure the carrying trade from the West, by canalising the rivers between Montreal and Lake Erie wherever the rapids interfere with traffic. The traffic has grown so enormously since the construction of the trans-continental line of the Canadian Pacific opened up the great western plateaus for settlement, that the older systems of canals are practically useless. The actual piece of work described in the paper was the building of Soulanges Canal, on the northern bank of the St. Lawrence, a short distance above Montreal. Two very important departures from ordinary practice were adopted on the advice of Mr. Munro, who was sent on a tour through Europe by the Government before the work was planned: in the first place, the locks are practically all at the Montreal end of the canal, and the lift in each lock was much greater than had previously been attempted in Canada, the locks being also of great size; in the second place, Portland cement concrete has been extensively used. Hitherto Canadian engineers have been afraid to use this valuable material in their canal and harbour work, mainly on account of the fear that the severe Canadian winters would break up such material; partly also, at any rate, until a few years ago, from the difficulty of obtaining trustworthy cement. Recent advances in the manufacture, both in England and the continent, stimulated mainly by the exhaustive series of tests carried out on Portland cement by Bauschinger and others, have resulted in putting at the disposal of Canadian engineers a material thoroughly trustworthy and uniform in quality; and Mr. Munro's experience has proved decisively that with adequate care in the preparation and use of the concrete it is perfectly safe in the most rigorous Canadian winter.

At Montreal the members of the section had the opportunity of thoroughly inspecting the magnificent engineering laboratories of the McGill University, built and equipped by Mr. McDonald, one of the most generous in his gifts of the many public-spirited citizens of that flourishing city. These laboratories are in many respects the most perfectly equipped in existence, especially the hydraulic room designed by Prof. Bovey, where the visitors were shown most ingenious appliances for studying some of the more difficult problems in hydraulics, some of the appliances as, for example, the experimental steam pump, which has just been installed, being on an extensive scale, and fitted for all the requirements of complete research work. Prof. Bovey supplemented this visit by a paper read before the section describing in detail the various appliances in this hydraulic laboratory.

One of the most interesting discussions in the meeting of the section was started by another paper of Prof. Bovey, describing the method of testing Canadian timbers at the McGill laboratories, and the results he had obtained as to the influence of moisture on the strength and elasticity of the various woods experimented on. The timber industry is such a valuable one, both to Canada and the States, that special attention has been devoted to the thorough testing of the economic values of the different forest trees. It should be remembered, however, that Bauschinger indicated the true method of making such tests in his memoirs on testing of timber specimens: all the later experimenters have simply followed in his footsteps The results of the exhaustive tests carried out in the States by Prof. Johnson have been published in a series of Bulletins by the Forestry Branch of the Department of Agriculture at Washington; these form a valuable series for reference.

Prof. Callendar described in a brief, but most valuable paper, which will be published *in extenso* in the transactions of the British Association, the apparatus devised by himself and Prof. Nicolson for studying the rate of condensation of steam when in contact with metal surfaces at various temperatures and pressures. The research is still incomplete, so that it is impossible to deduce any very certain generalisation from the results so far obtained with the apparatus; but one thing has been clearly brought out, namely, that the rate of condensation is not as great as has hitherto been assumed in theoretical investigations into this all-important question in the true theory of steam engine efficiency.

On the Saturday the members of the section had the opportunity of joining an excursion to Niagara, and of seeing while there the various power-houses, and some of the industries which make use of and depend for their existence on this cheap and abundant power. Nothing has been more instructive to English visitors than the constant utilisation of the energy of the falls and rapids, so abundantly distributed all over Canada, and nothing perhaps more striking than the fact that some of these power companies find it difficult to dispose of the power they are ready to supply, a testimony to the truth of the statement that after all in many very important industries the cost of power is not a very serious factor in the cost of production.

As every city of any size, both in Canada and the States, is always well equipped with electric tramcars or street railroads, usually running many miles out into the country around, it was only fitting that the section should devote a good deal of its electrical day to papers on this question, so rapidly becoming one of the leading problems of municipal engineering work in Great Britain.

Mr. Cunningham, the engineer responsible for the construction and working of the very complete system in use in Montreal, read a paper descriptive of that work, but in doing so he dealt fully with the whole question of electric as opposed to other systems of traction. Here, again, many members had had an opportunity of inspecting the power-house of the company at Montreal, and were able, therefore, to follow more readily the author's description of the plant in use.

Mr. Cunningham, no doubt, somewhat overstated his case when contrasting the cost per car mile of the horse system of Liverpool with the electric system of Montreal; it is certainly not a fair comparison to take the mere cost of power as delivered from the power-house, neglecting all the expense of maintaining the generating plant in prime cost condition, repairs to car motors, lines, &c., and then to contrast this with the published cost of haulage per car mile of some horse system, where not only has the cost of fodder and wages of stablemen been included, but also the heavy outlay of up-keep of the horse stock. There can be no doubt that such comparisons have often led municipal and other authorities in Great Britain to look with great suspicion on estimates of electric street railway systems, and have at times hindered their adoption. The distinct economy of electric haulage, when every item of cost has been fairly brought into the bill of charges, is so clear that it needs no such unfair method of comparison to bring it home to those interested in tramway work.

There was a long discussion on this paper, and on a second paper, by Mr. Aldridge, descriptive of a very ingenious but

somewhat complicated electric system designed to get rid of the overhead wire, the car itself carrying a length of wire overhead sufficiently long to make connection between a series of poles and studs in the paving. The general opinion of all the electrical engineers who took part in it, both British and American, seemed to be that for smaller towns with comparatively uncrowded streets, and for the outlying roads of great cities, especially those extending into residential suburbs (most of the existing tram-lines in London run mainly on such roads), the overhead trolly wire system was at present, at any rate, the only possible system; its great cheapness and simplicity, as compared with all conduit systems, practically gave it a monopoly. For the main business streets of great cities, however, if street tramways are to be allowed at all, a somewhat doubtful point, then some system which abolishes both the overhead wire and the open conduit seems the ideal one. At present no satisfactory one has yet been brought into use. One thing is certain: every British visitor to Toronto, after experiencing the comfort and value of the quick, well-lit, and frequent car service of that city, will return to the Old Country an ardent advocate of the adoption of electric traction on our street-cars. The contrast between this splendid system of street-cars and our slow, wretchedly-lit system is so great, that one can only wonder that we have put up with the latter so long. The abolition from our streets of the thousands of horses required by tram-cars and busses, is of itself a great argument in favour of electric traction; the filth of the streets would at once be sensibly reduced, and we should be spared the pain of seeing the sight—now only too common in our streets—of overworked horses struggling painfully to start overloaded cars and busses.

The bugbear of the hideousness of the overhead wire is, let us hope, at last being seen in its true light; in any street of Toronto, where the overhead wires of the car-system were the only ones, they were inconspicuous and almost unnoticeable; the people responsible for the frightful mass of wires and poles which disfigure the leading streets of American cities, are not the tramway companies, but the telegraph, telephone, and electric light companies. The overhead wire tramway poles would be practically unnoticeable in any street of an English city; and most certainly there are very few, if any, streets where they would be obtrusive, or do anything to increase the already, alas, existing prevalent ugliness.

The conditions of modern city life, the absolute necessity of the worker living—if he is to secure a healthy cheap dwelling—miles from his place of work, render imperative some system of cheap and efficient transport through the streets. Though our underground electric railways may do something towards solving this problem in London, still, in the other cities, and in London itself, the street-car must be the chief method adopted; and it is monstrous that we should still be compelled to put up with our antiquated and inefficient system of horse traction, while every little town of mushroom growth in America has already solved the problem, and given its inhabitants the most perfect systems of street traction. Liverpool is to show the way; let us hope, that in a year or two the electric street railways of great Britain will increase so rapidly that we shall be able to compare them, as regards mileage, with the thousands of miles already in use across the Atlantic. If the meeting of the Association in Toronto should hasten on this desirable social improvement, it will not have been in vain, and will be looked back to with pleasure by all those anxious to make life in our great cities more healthful and more perfect.

THE WORK OF PASTEUR AND THE MODERN CONCEPTION OF MEDICINE.

MR. PRESIDENT, LADIES, AND GENTLEMEN,—It is not without emotion that I rise to address this learned assembly. I know, indeed, that I am addressing men who are not my fellow citizens, but among them are some, *enfants de notre vieille nation Gauloise*, who have the same mother tongue as we; they speak from childhood our beloved French language, they are thus a little more than my fellow citizens, for they are my compatriots, and I feel myself animated by a truly fraternal affection for them; and as to my English colleagues, they have given evidence of so much good will and of a courtesy so delicate, that I need make no great effort to assure them of my gratitude. In one word, although a stranger I seem to be among friends.

I am somewhat troubled, also, because I am addressing medical men and am speaking before a medical congress. Now, although I belong in some small degree to the great medical family, since my father has conferred honour upon the profession of medicine by his labours and by his works; and although I have the great honour to be the delegate of the Faculty of Medicine of Paris, yet I am not a medical man, and a physiologist displays some temerity in venturing to speak before you on medical matters.

THE RECONCILIATION OF MEDICINE AND SCIENCE.

Still I have an excuse. It is this, that I desire to attempt to bring about a complete reconciliation between medicine and science. It may seem that this is a commonplace, and that any such attempt would be unnecessary. But it is not so, gentlemen. We might find, perhaps, somewhere—not, I am sure, in this assembly—medical men ready, unhesitatingly, to assert that there is discord between medicine and science, and that all those sciences which are called auxiliary—physics, chemistry, physiology—are *impedimenta* with which the clinician has nothing to do. Yes, there are to be found in the world medical men, among them even men of high attainments, who are ready still to say: "What have I got to do with your experimental science? Observation of the sick and clinical study are worth more than all your clever experiments, and it is not from laboratories that the means of curing disease can come." Such an opinion appears to me to be erroneous, and I would with all the energy which I possess help to upset it. I hold that it is by experimental science alone that medicine has made and can make progress. It will suffice to describe the work of Pasteur, my illustrious master, in order to give you a convincing demonstration of this.

I shall not be contradicted when I say that the value of this work is greater than all that the history of medicine has given us since the commencement of our era. Through his labours everything has been renewed, regenerated, and, thanks to him, medicine has made more progress in twenty years than had been made previously in twenty centuries.

THE LIFE-WORK OF PASTEUR.

Louis Pasteur was born at Dôle in the Jura in 1821, and at the beginning of his career gave himself up to the study of chemistry. He became deeply interested in a difficult and important problem—molecular dissymmetry. Here was a question in pure chemistry which would seem to take us very far from medical questions, but it was to lead Pasteur directly to the study of fermentations. If a solution of tartaric acid (in the form of tartrate) be left untouched, a change occurs after some time in the chemical constitution of the liquid, which before Pasteur's time had been overlooked. The original solution had no action on polarised light, but after fermentation this same solution has become capable of deflecting polarised light. Pasteur explained this phenomenon by showing that the original tartaric acid is a mixture of an acid deviating light to the right with an acid deviating it to the left, and that a process of partial decomposition takes place; one of the acids is destroyed and the other is not altered, so that the action upon polarised light, previously masked by the mixture of the two acids, becomes evident. Here we have a fundamental experiment. It is told how when the young Pasteur desired to show it to Biot, that great physicist, who had discovered the phenomena of polarisation, the old *savant* grasped the trembling hand of the young man, and, before beginning the optical examination of the crystals submitted to him by Pasteur, said to him with tears in his eyes, "*Mon cher enfant*, I have loved science so much, that in face of the beautiful experiment which you relate to me I cannot prevent myself from being deeply moved."

The explanation given of this phenomenon at that time was that the tartaric acid was decomposed by fermentation. Men were then content to use this magic word, which appeared to explain everything, but which in reality told nothing at all. Neither Lavoisier, nor Liebig, nor Frémy had been able to discover its meaning, and were reduced to the theory of half-organised matter—a childish conception worthy of Paracelsus.

One of Pasteur's experiments, perhaps the most beautiful which he ever made, demonstrated the nature of this mysterious phenomenon. If a sugary solution of carbonate of lime

[1] An address delivered before the British Medical Association, at Montreal, by Prof. Charles Richet. (Reprinted from the *British Medical Journal*.)

is left to itself, after a certain time it begins to effervesce, carbonic acid is evolved, and lactic acid is formed, which decomposes the carbonate of lime to form lactate of lime. This lactic acid is formed at the expense of the sugar, which disappears little by little. But what is the cause of this transformation of sugar into lactic acid? Well, Pasteur showed that the efficient cause of this chemical action was a thin layer of organic matter; that this layer of organic matter consisted of extremely small moving organisms, which increased in number as the fermentation went on. Their growth it is, then, which produces the phenomenon of the transformation of sugar of milk into lactic acid. If, for example, we take a sugary solution in which all pre-existing germs have been destroyed by heat, no lactic fermentation will take place. But if we introduce into this sterile liquid a small quantity of this layer of organic matter, such as can be obtained from any liquid in which normal lactic fermentation is taking place, we shall see the lactic acid again form rapidly in the new solution.

Let us dwell a little on this admirable experiment. Nowadays it seems to us so extremely simple that we can scarcely perceive its importance. It seems to us now, in 1897, that from all time we must have known that an organic solution when heated was sterile, and that a germ would suffice to render it capable of fermentation. But this is a mere delusion. No, a thousand times no! This great fact of the generation of germs was absolutely unknown before Pasteur, and the method of sterilising liquids, and of their inoculation with spores, was revealed to us by Pasteur. It is the nature of great discoveries that they become popularised in a short time, and thus very quickly become elementary. A first year's medical student knows perfectly that which neither Lavoisier, nor Liebig, nor Frémy, nor any one before Pasteur had been able to perceive. We are always tempted to be ungrateful to great creators, for their creations pass rapidly into the domain of common knowledge. They become so simple that they cease to surprise us. We do not think of being grateful, and we forget the efforts which genius has had to make to wrest the truth from jealous nature. Gentlemen, let us not be ungrateful, let us remember that the recognition of the real cause of all fermentation (the development and germination of organised elements) dates from 1857, and from the celebrated memoir of Pasteur upon lactic fermentation. A new world was then opened to science.

Nevertheless, this memoir of Pasteur's, containing one of the fundamental discoveries of the century, was not welcomed as it ought to have been. At first its importance was not understood, and afterwards absurd contradictions were opposed to it. A whole series of beautiful and decisive experiments was necessary to prove that there was no such thing as spontaneous generation, and that sterile liquids remained sterile indefinitely so long as no germs were introduced into them. Pasteur devoted six years (1857–1863) to the proof of the fundamental fact that "organic liquids do not alter until a living germ is introduced into them, and living germs exist everywhere."

THE MICROBIC THEORY OF DISEASE.

A great step yet remained to be taken. This was to determine the evolution of these germs, not merely *in vitro*, but in the living organism. We to whom the idea of parasitism and microbic infection is now so familiar can scarcely conceive that it has not always been thus.

The microbic theory has become so ordinary, so popular, that we are tempted to believe that the part played by microbes was understood even in the times of Hippocrates; but I assure you that in truth this was not the case, and for long enough after Hippocrates the power of microbes was not known.

Pasteur, to whom, and to Sédillot and Littré, we owe the word "microbe," was the first also to explain to us in his essay on the silkworm disease, published in 1867, the part they played in the production of disease. He proved that the bright corpuscles found in the bodies of diseased silkworms are living germs—a distinct living species, a parasite which can multiply and reproduce itself and disseminate the contagion.

It was therefore with painful astonishment that I heard Prof. Marshall Ward recently say that the discovery of the part played by micro-organisms in disease was due to Koch, and dated from 1876. Now, ten years before this, Pasteur had published his experiments on *pébrine* and *flacherie*. Davaine had shown the part played by bacteria in anthrax infection, and the idea of infection and of contagion by microbes in the higher animals as well as in the lower had become a commonplace, not indeed in the medical world, but in all laboratories.

Thus, by successive steps, did the work of Pasteur develop in all its greatness and logic. In the first place, in order to elucidate a chemical problem, he studied tartaric fermentation; then he was led to study lactic fermentation, and he showed that they were biological phenomena. He then pursued the analysis of this phenomena with all its consequences, and was led to the conception that disease was due to the development of a parasite.

The normal living being follows out its course of growth without the development of any organic parasite in its tissues or in its humours. But if these humours or tissues happen to be inoculated with any organism capable of developing, then this small living thing multiplies, the higher organism is infected, and the whole body becomes, as it were, a culture fluid, in which the pathogenic microbe propagates itself, a centre of infection which scatters the disease by sowing the noxious germs wherever it goes. Thus arose the new conception, profoundly new not only for medicine but for hygiene—Disease is Parasitism. Thenceforth we understood the meaning of the words "infection" and "contagion," previously mysterious.

It is true that Pasteur did not discover all the microbes of all contagious diseases; but this is of small moment, since he was the first to discover that infection was a phenomenon of microbial parisitism. All those who after him have proved points of detail, however important or fundamental they may be, have but followed the path traced by the master. Whether they will or not, they are all the pupils of Pasteur, as those who follow the study of chemistry are pupils of Lavoisier.

The greatest of Pasteur's disciples, Robert Koch, although with some ingratitude he refuses to recognise his master, has only perfected certain points in technique and applied his ingenuity and his perspicacity to the solution of questions which, in spite of their practical importance, are still secondary. He has not, in fact, been able to do anything new except upon points of detail; all that is essential comes from Pasteur himself.

Need I say that this idea of the microbe, of the parasite, has become the basis of medicine. If we take up treatises on pathology written before this prodigious revolution, we shall be astonished by the insignificance and the nothingness of these very ancient books. Yet they are not really very old; they are dated 1875 or 1880; but as one reads them it seems as though several centuries must have intervened between these venerable writings and modern books. I know an excellent article on tuberculosis written in 1878, before the microbe of tuberculosis had been discovered. Well, this article belongs to another age; it belongs no longer to medicine, but to the history of medicine, for it swarms with mistakes and incredible errors with regard to pathological anatomy, etiology, prophylaxis, treatment—in fact, from every point of view.

In ten years medicine has been entirely overturned and remade. It is being re-made every day. Every day brings some new discovery in matters of detail; but the great principle is always there, and it must always be attributed to the one initiator.

This is not all. Another new and great discovery was to be made by Pasteur himself, and to constitute the supreme development, the culminating point, as it were, of his life's work. This is the principle of vaccination. By a series of researches, admirable for their precision, Pasteur proved that the pathogenic microbe could be attenuated—that is to say, rendered incapable of causing death. But, though this microbe does not cause death, yet it can produce the disease, a disease sometimes so attenuated as to be almost imperceptible. Now the living being which has suffered from this attenuated disease is protected against its more serious forms, and, borrowing the word consecrated by the immortal discovery of Jenner, Pasteur said that we have here "vaccination."

Fermentation, infection, contagion, vaccination; here in four words we have the work of Pasteur. What more need I say? Do not these four words possess, in their simplicity, unequalled eloquence.

Can any one longer maintain that the progress of medicine is not due to experimental science? Does not all this knowledge of microbes and of the part which they play in disease imply, immediately and necessarily, immense progress in therapeutics?

ANTISEPTIC SURGERY.

To take but one example, I will cite the application of microbial theories to surgery.

There was a time when erysipelas, purulent infection, and hospital gangrene decimated those upon whom operations had been performed, when puerperal infection claimed a terrible number of victims. It seems to us nowadays that the medical profession before 1868 were blindfolded, and that their blindness was almost criminal. These are now no more than historic memories. A sad history, doubtless, but one which we must look at coolly in order to understand what science can do for medicine. Left to their own resources, practitioners of medicine during long centuries could do nothing against erysipelas, against purulent infection, against puerperal infection; but, basing itself upon science, surgery has been able to triumph over these odious diseases, and to relegate them to the past.

Let me here introduce a reminiscence. When on the occasion of his jubilee, a great celebration was prepared for Pasteur in the Sorbonne, in the presence of the leading men of science of the world, there was a moment when all hearts were softened —the moment when the great surgeon who was first to perceive how to apply to the practice of his heart the theory of pathogenic parasites, when Lord Lister drew near to Pasteur and gave him a fraternal embrace. These two great benefactors of humanity, united in their common work, afforded a spectacle never to be forgotten, a striking reconciliation of medicine with science.

But the apogee of the glory of Pasteur was the discovery of the new treatment of hydrophobia. No one of his scientific conquests was more popular, and from France and from the whole world there arose a long cry of admiration. Perhaps in the eyes of biologists this discovery possesses less importance than his labours with reference to the fermentations and to vaccination, but for the public this was the chief part of Pasteur's work. And men of science also were forced to admire the scientific courage of Pasteur, who, putting aside the precise methods which he had taught and discovered, knew how to devise new methods to meet the exigencies of the circumstances, and how to put them victoriously into practice.

Thus was finished the work of Pasteur. He was spared to take part in the triumph of his ideas, and to be a witness of his own glory. If, like so many creators, he had sometimes in his earlier days known conflicts and hatreds and petty quarrels and foolish objections, nevertheless he had not to deplore the ingratitude of mankind. He died full of honours, surrounded by admiration, respect, and love. For him posterity had already commenced when he died.

THE UNION OF MEDICINE AND SCIENCE.

And now let us turn back to consider the indisputable union of medicine and of science. This, in fact, is what ought to strike us in the work of Pasteur. It is not only in general biology and in the progress of our knowledge that his work is great; it is still more in its immediate practical applications. The great biologists of our century, Lavoisier, Claude Bernard, Darwin, have, without doubt, left behind them work which by reason of its conquest of new truths is not inferior to the work of Pasteur, but these new truths do not lead to any such immediate application as antisepsis, the treatment of hydrophobia, anthrax-vaccination, or the prophylaxis of infectious diseases. Pasteur was not only a man of science, he was also a philanthropist, and there is scarcely one who can be compared with him as a benefactor of suffering humanity except Jenner, who found out how to preserve thousands and thousands of human beings from the most hideous of all diseases.

Further, Pasteur brought back medicine into the true way of science. Even after Magendie, Müller, Schwann, and Claude Bernard, it might still have been asked whether all these experiments establishing so many important truths had really been of any advantage for the relief of the sick. To discover, as did Schwann, that living beings are an aggregate of cells; to prove, as did Claude Bernard, that the liver forms sugar; to establish, as did Darwin, that living species can be transformed by the influence of long-accumulated variations in the environments—these are admirable pieces of work, but work in pure science which had not any immediate therapeutic results. Strictly speaking, then, it was possible to maintain that clinical medicine did not derive any benefit from such investigations. I do not for a moment believe that this opinion had a shadow of a foundation, but before the time of Pasteur it was not so absurd as it has become since Pasteur. Since Pasteur no man can, without incurring the charge of monstrous ineptitude, refuse the rights of citizenship in medicine to experiment and to biology.

And to speak the truth, men of science and biologists, as though their ardour had been redoubled by the renovation of medical ideas, have during these last ten years made discoveries which have introduced into medical science new elements which clinical observation alone had been absolutely incapable of discovering. I will cite a few examples—the action of the thyroid gland, the Röntgen rays, pancreatic diabetes, and serum therapeutics.

THYROID IN THERAPEUTICS.

Physiologists had shown long ago that the ablation of the thyroid gland led to serious results. Schiff had proved this as long ago as 1857, but the explanation of the phenomenon did not become clear until Claude Bernard, but especially Brown-Séquard, had demonstrated the existence of internal secretions of glands pouring into the blood their products which probably neutralise certain toxic substances. This very naturally led Vassale and Gley to inject into animals from whom the thyroid gland had been removed the juice of the thyroid, and thus prolong their lives. The therapeutic conclusion to be drawn was obvious, namely, to treat the unfortunate subjects of cretinism or of diseases of the thyroid gland by injection of extracts of the thyroid body. You know that the result has been most happy.

This new treatment was a true experiment, and as is the case with so many experiments, the actual result has been a little different from that which was expected. The ingestion of thyroidin is not only a means of curing goître and cretinism, but is only a treatment, sometimes remarkably efficacious, for obesity.

THE RÖNTGEN RAYS.

The discovery of the Röntgen rays excited general enthusiasm, and as a matter of fact it is one of the greatest conquests of contemporary physics. Most assuredly medicine had nothing to do with it. The research was made and the success was obtained in a physical laboratory. Now you are not unaware that these Röntgen rays have been called to play a part, if not in the treatment at least in the diagnosis of diseases—a part the importance of which goes on increasing from day to day. Physicists have discovered the principle, it is for medical men to follow up its application.

PANCREATIC DIABETES.

The existence of pancreatic diabetes was suspected vaguely by a clinical physician, Lancereaux; but the means which clinical medicine and pathological anatomy placed at his disposal did not give him the power to solve the problem. In spite of his perspicacity, he could do no more than note a certain correspondence between diabetes and lesions of the pancreas. How could more have been learnt if we had not the resource of experiment? Two physiologists, Mering and Minkowski, have had the good fortune to show that ablation of the pancreas determines glycosuria, to show that there is a pancreatic diabetes, and they have studied its various conditions with great ability.

SERUM THERAPEUTICS.

I come now to serum therapeutics, a direct consequence of the labours of Pasteur. This is a mode of treatment born of the experimental method alone. Here, again, science has done for the art of medicine that which clinical observation, left to its own resources, could never have accomplished.

Permit me now to show how serum therapeutics is derived directly from physiology and experiment, and pardon me if I am forced to speak of my own work; I shall do so I hope without any vanity. I know very well that we always owe to our predecessors and to our rivals much more than our pride admits, and that the experiments and the ideas which succeed are not always those which have been conceived most methodically.

About 1887 M. Chauveau had shown that French sheep could contract anthrax, and that they are very easily infected by the bacillus anthracis, the microbe of anthrax, if small quantities of the bacillus be injected under the skin. But Algerian sheep seem to be safe from the disease. In vain is the bacillus anthracis injected into them; they do not contract

anthrax. They are refractory to this disease and possess a remarkable immunity to it. Having reflected on this strange fact I framed the hypothesis that the cause of the immunity of the Algerian sheep, which are absolutely similar from the anatomical and zoological point of view to French sheep, depended upon chemical substances contained in the blood, and that in consequence we might hope to confer immunity on French sheep by transfusing into them the blood of the Algerian sheep. It is, however, difficult to make experiments on sheep. Therefore, with my friend Héricourt, who has been throughout these researches my tireless fellow worker, I took animals of two different species, the common victims of physiologists—rabbits and dogs.

Just at that time we had been studying a microbe nearly related to the staphylococcus albus, the staphylococcus pyosepticus, which in rabbits produces enormous subcutaneous swellings when injected under the skin and causes death in twenty-four to thirty-six hours. The dog, on the other hand, seems to be almost refractory to inoculation with this microbe. We therefore attempted to transfuse the blood of the normal dog into rabbits by intravenous injection, but this operation did not succeed, for the transfusion of dog's blood into the veins of the rabbit even in a dose of only 10 gm. rapidly causes death.

In then occurred to us to resort to peritoneal transfusion in place of intravenous transfusion. In this way we were able to introduce into the organism of the rabbit 50 or 60 gm. of dog's blood, and had the good fortune to see the experiment succeed completely. Rabbits transfused with the blood of the normal dog survived the inoculation of the microbe for four or five days, and rabbits transfused with the blood of a dog vaccinated against the microbe did not die, and were in fact hardly ill at all.

This experiment, which was made on November 5, 1888, is, as it seems to me, the very basis of serum therapeutics; it in fact proves that the blood of animals refractory to a disease contains chemical bodies which counteract the effects of the specific pathogenic microbe of the disease. We understood its importance from the first, and having established the general pathological principle, we resolved to apply it to a disease of man.

For several days, then, Héricourt and I debated the question whether we should experiment with one or other of the three diseases—anthrax, diphtheria, or tuberculosis. Unfortunately we decided for tuberculosis. Its microbe is easily cultivated, and, as you know, it produces greater ravages among men and animals than any other disease. We set to work at once, but, as you will understand, time was required before we could obtain definite results. Still, in a year's time we were able to show that the injection of dog's blood into rabbits retarded enormously the development of tuberculosis. It was, nevertheless, necessary to pass from experimental physiology to human therapeutics. Taking advantage of an observation of Bouchard's to the effect that the serum of refractory animals is as active as the whole blood, we were able to inject the serum in tuberculous diseases. The first sero-therapeutic injection was made by us on December 6, 1889.

At first we had for a space great hope. Yes, in truth, for several weeks we believed that we had discovered the heroic treatment of tuberculosis. For several weeks the various patients that we had under treatment found that their strength was renewed, that their appetite returned, that their weight increased, and that cough and expectoration disappeared almost completely. But, alas, it was no more than a transient improvement. A month or a month and a half later the pitiless disease resumed its course, and the sero-therapeutic treatment turned out to be inefficacious. Happily, while by the most diverse plans we were in vain searching for a method of treating tuberculosis by serum, a German experimenter, Behring, after studying the effects of the serum of refractory animals upon diphtheria, showed (in 1892) that this serum is wonderfully efficacious in the treatment of the disease. He applied the serum method of treatment not only to diphtheria, but also to tetanus, and, at first in animals and afterwards in man, he obtained results which were really marvellous. Gentlemen, you know the rest, and I need not tell you that this sero-therapeutic method, improved and popularised by Roux in 1894, is now a treatment without compare. The statistics on this head are absolutely conclusive. The mortality of diphtheria, which was 45 per cent., has fallen to 15 per cent. That means for the city of Paris alone an annual saving of about 1000 human lives; for the whole of France nearly 10,000 lives. We may take the same proportion for Italy, Germany, England, the United States, Canada, and Russia, and may estimate the number of infants which serum therapeutics snatch from death at about 50,000.

In other diseases the results of serum therapeutics have been much more open to criticism, and it would be necessary in order to arrive at a satisfactory conclusion to discuss them in detail. I cannot attempt to do this here, for it would be an abuse of your patience. I will content myself by venturing the opinion that serum-therapy has not said its last word. The organism is endowed with a marvellous power of resisting the poisons secreted by microbes. It sets to work in its turn to secrete counter poisons which neutralise the poisons secreted by the microbe. The antitoxins of the organism combat the toxins of the parasite, and in the future the art of serum therapeutics will be to seek in these resisting organisms the antitoxins fabricated by their cells.

MEDICINE AND EXPERIMENTAL SCIENCE.

Thus on whatever side we turn we find that medicine has always been guided by experimental science. By experiment and by science it is compelled to march forward. This was true in the time of Harvey, for that immortal physiologist had to meet the opposition of physicians. This was true also in the time of Lavoisier, when by a few decisive experiments he proved the chemical nature of the phenomena of life. But how much more true is it at the present time since Pasteur has by experiment laid open a whole world, and has warranted us in conceiving the widest hopes for the future of medicine?

The parts of the man of science and of the physician are very different. The physician ought to be conservative, applying methodically the teaching and the precepts which he has received. He has no right to experiment upon his patients, or to permit human life or human suffering to be risked on fantastic theories. But the man of science ought to be a revolutionist. He ought not to be content with the doctrines which he has been taught. The opinion of the master ought to be but a light weight upon his mind. He ought to seek on every hand for facts which are new and even improbable. Darwin says somewhere that he had made the experiments of a fool, and often it is right to attempt that which appears contradictory to all the most received and classical opinions. Without this spirit of adventure, without this scientific daring which opens up new horizons there is no progress.

The task of the explorer or of the pioneer is not that of the physician. He ought to be careful to keep himself abreast of all scientific progress in order that his patients may have the benefit of it, but he cannot advance the progress of science, save within restricted limits. Having no right to experiment, he is almost powerless to solve the difficult problems which arise.

It is the duty of the chemists, the physicists, and above all the physiologists, to guide medicine into the new ways. They have not to take the heavy responsibility of a human life upon their shoulders, and nothing ought to check their audacity. You, gentlemen, have not the right thus to be audacious: you need prudence and moderation, and, convinced as I am of the power of experimental science, I still think that the applications which the chemists and the physiologists suggest to you should only be accepted with considerable caution. It costs us nothing, after a few experiments which have succeeded fairly well, to say to the physician, "Try that on your patients." You know very well that our responsibility is *nil*, and that the ancient axiom *primo non nocere*, an axiom which ought to be your strict rule of conduct, does not in any way apply to us. You see, therefore, that it would be unjust to make it a matter of reproach to physicians and surgeons that they have not made great scientific discoveries. This is not their mission. It is theirs to relieve human suffering, and to seek among new scientific truths that one which is most proper to relieve or to cure the sick.

Nor can I understand how any one should have wished to create an antagonism between medicine and science. To suppose that they are in contradiction is to show that we understand nothing about either the one or the other. It is not reasonable to assert that the one is superior or inferior to the other; they are different in their means and in their ends. They are mutually complementary, and both are equally necessary.

If I were ill most assuredly I would not seek the assistance of a chemist, or of a physiologist, and medicine is not to be learned from the books of Claude Bernard or of Pasteur. Clinical instruction is necessary, such as long observation of patients alone can furnish. Prophylaxis, diagnosis, prognosis, therapeutics are not to be learned in scientific books. Something else is necessary—observation, long, patient observation, the old Hippocratic observation, without which there can be no good physician. Young students must be guided in the examination of patients by experienced practitioners, and no one, I presume, would be guilty of the folly of proposing to replace the clinical ward by the laboratory.

But without laboratories the clinical department must remain incapable of scientific advance, and this condition of stasis is assuredly undesirable; for in spite of all the progress which has been made, much yet remains to be done. Are not tuberculosis and cancer, for example, the disgrace of medicine? I appeal to all medical men here present. Is there any one of you, gentlemen, who in the presence of such painful modes of death does not feel himself humiliated to the bottom of his soul by his powerlessness?

Well, this feeling of our present powerlessness against disease ought to stimulate us to work. The work to be done is enormous, and we must none of us grow weary of our task. We physiologists must seek new facts, we must seek and seek again, seek always without being afraid of the boldest hypothesis, and without putting any limit to our audacity, without troubling our heads as to the practical consequences which may flow from our discoveries, having only truth—divine truth—for our object. As for you, gentlemen, it is your duty to follow with the warmest interest both the general effect and the detailed results of biological discoveries in order to attempt to find some practical application for them. From this unceasing collaboration progress will be born. But it is necessary that men of science and physicians should both be animated with these two governing sentiments—faith in science and love of man.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Athenæum* says that a proposal is being considered to establish at Swansea, as a great manufacturing centre, a branch University College in association with either Aberystwith or Cardiff, as the Newcastle College is associated with Durham. The suggestion is that scientific and technical courses might be taken at Swansea in preparation for the Welsh University degree.

A SPECIAL course of instruction in electro-chemistry will be given during the coming session at the City and Guilds Central Technical College. The course will include practical instruction in electro-deposition, the use of the electric furnace, dynamos, transformers and accumulators. A great part of the time of the students attending this course will be devoted to electro-chemical research and the study of electro-chemical action. Candidates for admission will be required to submit evidence of having a general knowledge of physics and chemistry and of having been specially trained in one of these subjects.

A LONG article and a leader in yesterday's *Times* calls attention to the growth and present position of Higher-Grade Board Schools, of which there are about sixty now in the country, most of them containing over 500 scholars, while several have between 1000 and 2000. It is pointed out that schools of this kind are an organic growth, and have not come into existence, like so many technical classes, because a public body suddenly found itself endowed with money which it did not understand how to spend. Boys and girls are eligible for admission into the higher-grade schools after passing Standard VI. The course of instruction must include science, mathematics, drawing, manual instruction, English subjects, and at least one modern language. Science must be taught by means of laboratory instruction; and all subjects taught must be submitted to inspection. The course prescribed extends over four years, and during the first two years grants are not paid on individual successes in examinations, but are paid as capitation grants, the amount of which depends on the efficiency of the teaching, the school equipment, and the average attendance. The Department of Science and Art further insist that classes shall not be allowed to contain many more than thirty students, and for practical work they fix the absolute *maximum* at twenty-five. These rules have made it possible to give in higher-grade schools a thoroughly satisfactory general education, in place of the one-sided education that was formerly given. From their very birth higher-grade schools have had to encounter bitter and determined opposition. Opposition came in the first place from the ratepayers, but the main opposition comes now from small endowed schools, which are beginning to feel their competition, and from those persons who wish to see secondary education placed under county councils, and find that in large towns School Boards are already in the field. So far as the actual competition is concerned, it is, perhaps, to be regretted that a grammar school should be steadily emptied of its students to swell the numbers of an already overfull higher-grade school. When this happens there is, however, one way to stop it. Let the grammar school bring itself to that state of efficiency which has been forced upon the higher-grade school by the hostile public criticism it has had to meet, and the public inspection to which it has all along been submitted. This is the advice given both in the article and the leader in the *Times*. It is also pointed out that the fact that higher-grade schools have, in some places, half-emptied local secondary schools, so far as it is due to the better and more practical character of their education, is an object-lesson in favour of that organisation, and public inspection, of lower-grade secondary schools which educationists have so long desired.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 13.—M. A. Chatin in the chair.—On the permanent deformation of glass, and the displacement of the zero point of thermometers, by M. L. Marchis. An application of the theory of permanent deformations, due to M. Duhem, of which an account has previously been given.—On the electrolytic separation of nickel and cobalt from iron. Application to the estimation of nickel in steel, by M. O. Ducru. The solution of the sulphates of the metals is mixed with some sulphate of ammonium and excess of ammonium hydrate, and then submitted to electrolysis. The whole of the nickel, or cobalt, is deposited, together with a trace of iron. The latter may be determined by solution of the deposit in hydrochloric acid; and precipitation with ammonium hydrate, and a corresponding deduction made. Samples of steel are first dissolved in nitrohydrochloric acid, and then evaporated with excess of sulphuric acid. The test analyses given are very satisfactory.—The functions of the thyroid gland, by M. E. de Cyon.—On the respiration of *Carcinus mœnas* (Leach), by M. Georges Bohn. The author has observed, in this species of crab, the power of reversing the direction of the circulation of water in the branchial chamber.

CONTENTS.

THURSDAY, SEPTEMBER 30, 1897.

HISTORY OF ATOMIC PHILOSOPHY.

Histoire de la Philosophie Atomistique. Par Léopold Mabilleau, Professeur de Philosophie à la Faculté des Lettres de Caen. 8vo. Pp. vii + 560. (Paris: Félix Alcan, 1895.)

ALL things considered,[1] it seems probable that God, in the beginning, formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes, figures, and with such other properties, and in such proportion to space, as most conduced to the end for which He formed them; and that these primitive particles, being solids, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break to pieces; no ordinary power being able to divide what God himself made one in the first creation.

"While the particles continue entire, they may compose bodies of one and the same nature and texture in all ages; but should they wear away, or break in pieces, the nature of things depending on them would be changed. Water and earth composed of old worn particles would not be of the same nature and texture now with water and earth composed of entire particles at the beginning. And therefore, that nature may be lasting, the changes of corporeal things are to be placed only in various separations, and new associations, and motions of these permanent particles; compound particles being apt to break, not in the midst of solid particles, but where these particles are laid together and touch in a few points."

This statement of Newton's unites in a singularly complete fashion the various aspects of the atomic theory of which M. Mabilleau has given us a history in 560 large octavo pages. The author begins with a study of Kanada's theory, as examined by Colebrooke in his "Essays." Proceeding to the history of the subject in Greece, he leaves us in some doubt as to the precise influence of these earlier Hindu doctrines on the various Greek cosmogonies which, as he shows, developed in a natural and logical sequence in the hands of Thales, Anaximenes, Anaximander, Pythagoras, the Eleatic School, and Heraclitus, into a body of doctrines from which Leucippus and his disciple Democritus created the atomic theory, in a form but little different from that adopted centuries later by Newton. For Democritus, as for the modern chemist, composition was a union of atoms, and decomposition a separation of atoms, and matter, consisting ultimately of these atoms, was indestructible.

We have no space to follow M. Mabilleau in his detailed account of the modifications of the doctrine of Democritus by Epicurus; of its criticism by Aristotle; its revival in poetic form by Lucretius; and of the monotheistic atomic theory of the Motécallemîn in the Middle Ages, so fiercely attacked by Maimonides in his "Guide for the Strayed." There are, indeed, two aspects of the atomic theory (sufficiently apparent in the quotation from Newton given above) which, though perhaps not fundamentally separable, may yet be studied separately: the cosmical aspect, which offers us a hypothetical history of the universe; and the physical aspect, which offers us a hypothetical interpretation of actual phenomena. The study of the former aspect involves questions of religion and ethics, to which M. Mabilleau very rightly devotes considerable attention; but we have neither the space nor the competence to follow him far on this ground. The interest of the atomic theory from the scientific point of view begins again, after Epicurus, with the alchemists, who are claimed by the author as more or less conscious atomists; a view which might be discussed. But the great return to the theory came, of course, with the Renaissance and the return to the reading of Greek philosophers in the original. M. Mabilleau dismisses contemptuously the claims put forward by Lasswitz[1] for the Italians Giordano Bruno, Cardan, and Telesio as advocates of various forms of the theory, but, curiously enough, omits to mention Galileo, who can hardly be passed over in this connection.[2]

1 "Newton's Opticks," 2nd edit. (1768), Query 31, p. 375.

Bacon, already in the "Novum Organum" (1621) declared Democritus to have been the greatest philosopher of antiquity, but M. Mabilleau agrees with both Lange[3] and Lasswitz (and opposes Pillon and others), in regarding Gassendi's development of the doctrine of Democritus and Epicurus in the second quarter of the seventeenth century as the real turning point in its history,[4] and he even thinks that Gassendi's claims have been somewhat underrated hitherto; but if this is so, it is rather as a precursor of what M. Mabilleau calls Leibniz's "pan-psychical" monadology, than as a figure in the history of science.

Opposing Descartes' identification of matter with extension, Gassendi adopted the idea of solid, impenetrable and indivisible atoms, created in the beginning with certain properties as regards their movement in space, which control their future destinies completely; in addition he attributed to them a certain limited sensibility.

Gassendi is important from the scientific point of view, because he influenced Boyle,[5] who speaks of him in terms of sincere admiration.

We must remember that Boyle was the author of the modern theory and definition of the elements (a fact which M. Mabilleau, in his philosophic conviction that all matter is ultimately identical, passes over in silence); and that the conception of chemical combination, which has resulted from Dalton's theory, is thus really traceable to Boyle: though, as Roscoe and Harden have shown recently, it was, in its inception, due directly to the "Newtonian doctrine of repulsive atoms or particles."[6]

Very possibly, as M. Mabilleau thinks, Newton took Gassendi's doctrine from Boyle. To Newton's own view M. Mabilleau attributes the greatest importance, for he finds in him the mainstay of the atomic theory in its

1 In his able and learned "Geschichte der Atomistik vom Mittelalter bis Newton"

2 *Op. cit.* ii. 37 *sqq.*

3 In his "History of Materialism," translated by E. C. Thomas.

4 Lasswitz says: "Es war dieser Rückgriff auf die antike Atomistik, wenn er auch für die Geschichte der Philosophie keinen neuen Gedanken enthält, *doch ein schöpferische That in der Geschichte der Physik.*"

5 See, in Boyle's works, "Considerations . . . touching the origin of forms," and especially vol. ii. p. 483 (folio edition).

6 Roscoe and Harden's "New View of the Atomic Theory," p. 14 (published after M. Mabilleau's work).

widest sense. Unfortunately he totally misunderstands, if we are not mistaken, Newton's position.

It will be noticed that Newton puts his hypothesis among his famous *Queries;* he never abandoned the reserve expressed in his "Regulae Philosophandi."[1]

And secondly, when M. Mabilleau says that the theory of gravitation "means nothing if it does not mean that each atom of one body gravitates independently towards each atom of . . . (any other) body," because Newton said that the gravitation of a celestial body is the sum of the gravitations of all the *masses* of which it is composed, he appears to have been misled by the ordinary language of infinitesimal analysis. The atomic hypothesis essentially involves the discontinuity of all bodies. The theory of gravitation is equally true on the supposition that they are continuous, and, as a matter of fact, discontinuity of internal constitution is not taken into account in the mathematical analysis of gravitational phenomena. The point is of importance in judging M. Mabilleau's personal views, because, regarding Newton's law as "dans l'ordre des expressions phénoménales, la plus parfaite des formules, étant la généralisation et la plus haute et la plus exacte tout ensemble," he fallaciously adduces it as one of his most powerful arguments in favour of atomism.

M. Mabilleau discusses in some detail the views of Newton's contemporaries, Locke and Leibniz, those of Maupertuis, and later the dynamic theory of Boscovich. But from the time of Newton onwards he seems not only to have little acquaintance at first hand with his facts, but to be deserted by the powers of analysis and critical judgment shown earlier in the book. In his rapid rush through modern text-books and the popular articles of the *Revue Scientifique*,[2] he passes over the supremely important period of Black, Cavendish, Priestley and Lavoisier, in which the experimental method for comparing quantities of matter, failing which all theories of conservation of matter had been sterile, was arrived at; but quotes approvingly a view of "the great chemist Fechner" (who wrote two unimportant papers on chemistry) with regard to the connection between Newton and Dalton. He then analyses Dalton's work with some accuracy, and passes on to a *résumé* of the development of the atomic theory in chemistry since Dalton's time, mainly derived from Sir Henry Roscoe's address to the British Association in 1887, and Sir W. Crookes' lecture on the evolution of the elements. He notices the importance of modern theories of organic chemistry, but he fails altogether to recognise that (together with certain recent developments of chemical physics) they form absolutely the mainstay of the atomic theory in science. It is often hardly realised how unproductive of practical results the atomic theory has been elsewhere. Incidentally M. Mabilleau makes many mistakes, which imply a curious failure in the power to grasp a new subject, indispensable to the historian. Victor Meyer is supposed to have decomposed the atoms of simple substances; Joule to have proved that any change in molecular constitution is accompanied by an absorption of heat, and thereby to have inaugurated thermo-chemistry in 1872 (!); &c. The function of the atomic theory in physics is discussed in the brief space of five pages, devoted chiefly to the transformation of crystal forms with increase of temperature, and after a scarcely sufficient account of modern criticisms of the idea of continuity in pure mathematics, M. Mabilleau's book concludes.

[1] "In the particles [of bodies] that remain undivided, our minds are able to distinguish yet lesser parts, as is mathematically demonstrated. But whether the parts so distinguished and not yet divided, may, by the powers of nature, be actually divided and separated from one another, we cannot certainly determine" (*Principia*, trans. by Motte, edit. 1803, ii. 161).

[2] In which he misspells the names of most of the people he quotes, whether they are French or not. Thus we find, almost throughout, Schutzemberger for Schutzenberger, Malard for Mallard, Würtz for Wurtz, Hoffmann for Hofmann, Thornsen for Thomsen, Iungfleisch for Jungfleisch, Kirchoff for Kirchhoff, Lockyers for Lockyer, Krug (p. 521) for Krüss, Carnelly for Carnelley, Kékulé for Kekulé, &c. In one or two places Boyle is written Bayle, which might lead to confusion. But the climax is attained when, after some hesitation between the spellings Prout and Proust, with reference to the work done by these two chemists, the one English, the other French, M. Mabilleau identifies them boldly by writing (p. 516) "Prout (ou Proust)." Earlier in the volume we find Munck everywhere for Munk, &c.

He sums up in favour of the existence of atoms controlled by a transcendental law given at the creation of the world, the last sentence of the book being "Voltaire nous avait bien dit que la philosophie corpusculaire est le plus court chemin pour trouver l'Âme et Dieu."

This sentence explains the whole book, which is rather like the special pleading of an extremely supple-minded barrister than the work of an impartial historian. M. Mabilleau's book was written as a prize essay, and it obtained a prize from the French Académie des Sciences morales et politiques. But it was evidently written in a limited time, and, in consequence, M. Mabilleau's references are (and he does not conceal the fact) mainly second-hand. With references of this kind only an expert can deal with any degree of safeness, and in scientific matters, as we have seen, M. Mabilleau is far from being such.

For the historian of philosophy, M. Mabilleau's compilation will be useful. To the logical analysis of modern molecular and atomic theories, to which Stallo, Lasswitz, Mach, Pearson, Ostwald, and others have made valuable contributions, and which is still far from being exhausted, he adds nothing.

In conclusion, we may note that the book, though admirably printed and well arranged, has a most meagre table of contents and no index. P. J. HARTOG.

MAXWELL'S EQUATIONS OF THE ELECTROMAGNETIC FIELD.

Theory of Electricity and Magnetism. By Charles Emerson Curry, Ph.D. With a preface by Prof. Boltzmann. Pp. xv + 442. (London: Macmillan and Co., Ltd., 1897.)

A WORK on electricity and magnetism which, starting from the differential equations of the electromagnetic field, works backwards to the experimental phenomena, cannot well be used as a text-book by the beginner, but may be of great value to one who has already studied the facts and theories of the subject in their historical order. Of such a nature is Dr. Curry's treatise, the avowed object of which is, after forming certain conceptions and making various assumptions concerning the ether which practically constitute a formulation of Maxwell's theory, to derive therefrom, and explain thereby, all electric and magnetic phenomena. It is, in fact, a study in the interpretation of differential equations in terms of mechanical analogies or concrete

representations, and is an interesting example of the manner in which the theory of electricity and magnetism is treated on the continent.

It is assumed that electric phenomena are due to motion of some sort going on in every volume element of the ether, and the displacement produced by this motion is represented by a vector called the "tonic vector." Quadratic functions of the time differentials of the components of this vector are then assumed for the kinetic energy and the rate of conversion of electrical energy into heat, while the potential of the forces which resist the tonic motion is assumed to be a quadratic function of the curls of the same vector. The application of Hamilton's principle at once gives the equations of motion of the ether, and these, by a slight modification, become identical with Maxwell's equations. This modification is described by the author as a change in the system of units, but it is really a change in the system of quantities discussed.

In nearly all works on electricity this subject of units is treated in such a way that it presents a serious stumbling-block to the student. He is, for instance, almost led by the phraseology to suppose that quantities of electricity in the electrostatic and electromagnetic systems are quantities of precisely the same nature, just as are a pound and a gramme of water, for example; but that, being regarded from different points of view, they have somehow different dimensions in terms of the fundamental units; and not infrequently, by an exercise of faith rather than of reason, he believes this. A quantity of water may be measured either by its mass or by its volume, and, loosely speaking, either result is the measure of the quantity of water. But, speaking accurately, we cannot measure the quantity of water; we can measure certain properties of that quantity, of which one is the mass and another and different property is the volume. In a precisely similar manner electricity measured by the electrostatic system is one property of the electricity, and electricity measured by the electromagnetic system is another property; either may be arbitrarily defined as the quantity of the electricity, but it is inconsistent and misleading to describe both properties by the same name.

The concrete representation suggested as an interpretation of the Maxwellian equations is modelled on the theory of von Helmholtz, and is characterised by three main features. The first of these is the familiar conception of two incompressible fluids, the positive and negative *real* electricities; in a dielectric the real electricity is supposed to be bound, so that it cannot move out of the volume element in which it exists; but in a conducting medium it is capable of moving, and does so with a velocity proportional to the force acting on it. It is then found that, in the electrostatic state, the force acting on the real electricity is such as would be due to a certain distribution throughout space of a substance which repels the real electricity according to the law of the inverse square. An arbitrary multiple of the density of this supposed substance is defined as the density of the *free* electricity, and this constitutes the second main feature of the concrete representation. To bring about some simple relation between these two sorts of electricity the third main feature is introduced, namely the conception of electric polarisation; it is supposed that the real electricity within any volume element is capable of moving in such a way under the influence of electromotive force that positive electricity appears at one end of the element and negative at the other; thus there arises a density of electricity due to electric polarisation, and the definitions are such that at any point the density of the free electricity proves to be equal to the sum of the densities of the real electricity and of that due to polarisation.

Round these three conceptions are gathered several subsidiary definitions and suppositions, the mathematical reasoning being intricate and detailed; the whole constitutes a scheme of considerable complexity, of which indeed it is difficult to form a clear conception; as a physical theory, it would of course be extremely unnatural, but as a mere illustrative analogy it is instructive.

After considering Maxwell's equations of action at a distance, Dr. Curry shows by what assumptions and what modifications of the concrete representation we may pass from them to von Helmholtz's scheme; and he then considers the independent derivation of the latter from empirical laws.

There is an interesting chapter on the theory of the Hertzian oscillations, founded on Hertz's own memoir, but with the analysis given in greater detail. Other chapters deal with cyclic motions and illustrative mechanisms, with longitudinal ether oscillations, and with the theory of electric and magnetic striction.

The work is, on the whole, characterised by a clear style, though several serious difficulties are ignored, and some of the main features in the reasoning are not emphasised as their importance deserves. Thus in the transition from Maxwell's to von Helmholtz's equations the reader is left in considerable doubt as to whether certain of the suggested modifications are purely arbitrary assumptions corresponding to radical changes in the concrete representation, or merely a presenting of the old differential equations in a slightly altered form. There are also some serious errors which greatly disfigure the book, though fortunately they do not invalidate the leading argument. Thus on page 33 we are offered two different schemes of the dimensions of the quantities of the electrostatic system in terms of the fundamental units, a result due to a confusion of angular momentum with density of angular momentum. The kinematics on page 10 are faulty; and on page 23 we find the dissipation function spoken of as an energy function, and actually treated as such in the application of Hamilton's principle.

J. G. L.

OUR BOOK SHELF.

Reform of Chemical and Physical Calculations. By C. J. T. Hanssen, C.E. Pp. xvi + 72. (London: E. and F. N. Spon, Ltd., 1897.)

THE book deals specially with calculations of specific and latent heat, and heat of combustion of various substances. In the preface the author states that all his deductions are based upon the natural laws of atomic combination, heating, expansion and compression of aeriform substances, upon a few of the best substantiated experiments, and upon the fact, discovered by the author, that, near the 41° of latitude, the specific gravity of

oxygen gas of atmospheric density, at the temperature of freezing water, is exactly 1/700 of the gravity of distilled water, at its temperature of greatest density. He advocates this as an international circle of latitude for all gravitational calculations. The author says that "from this fact as a starting point, all fundamental values have been determined, and expressed with *absolute exactness* in units and vulgar fractions instead of approximately by rows of decimals," and he claims that his arithmetical method gives an "absolute accuracy of results, and a facility of manipulation not attainable by any other known method."

It is possible that the use of convenient vulgar fractions for physical constants may conduce to facility of arithmetical manipulation, but the author, for the sake of his vulgar fractions, makes assumptions which can surely not conduce to the absolute accuracy which he claims. For example, he takes 17/12 as the ratio between the specific heats of gases at constant pressure and at constant volume, because 17/12 is a simple fraction *not far* removed from the determined value of the ratio for simple gases, and, moreover, in spite of experimental evidence to the contrary he uses the same ratio in the case of such gases as CO_2. The author also advocates, and uses, a new scale of temperatures, not very different from the absolute Centigrade scale, to facilitate his arithmetical work. This he calls the normal scale.

The author makes a great number of calculations, arranging the results in tables. Where experimental evidence is at variance with any of these results he considers the experiments are inaccurate. The arithmetical work is conducted with considerable ingenuity, though occasionally the mode of statement of details is not unexceptionable, *e.g.* (on p. 24), log 0·00000 – log 0·21249 = log $\bar{1}$·78751 = 0·61307.

Prof. G. Karsten, of Kiel, has written an introduction to the book, in which he calls special attention to the author's proposal (mentioned above) that all observations and calculations on gravity should be referred to one common international circle of latitude, to be called the *circle of international gravity*. He also mentions § 80 and Table xxiii. as samples of the satisfactory results of the author's calculations and observations on heat produced by combustion, and recommends the book to the attention of scientific men.

The book on the whole, though the calculations are, in many parts, of considerable and varied interest, does not seem to justify its ambitious title.

Citizen Bird: Scenes from Bird-life in plain English for Beginners. By Mabel Osgood Wright and Elliot Coues. Pp. xiv + 430. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THIS book consists of a series of pleasant dialogues between Dr. Roy Hunter and some children, at Orchard Farm in New England, in which the children learn the appearance and habits of a great number of the birds around them. It has been rather unfairly compared in a daily paper to "Sandford and Merton." It must be allowed that the didactic dialogue is apt to be tiresome, and in this case the children are of course a little unnatural in their acuteness and their ardent desire to learn. English boys would probably learn better from a sound and scholarly handbook: one in whose hands I to-day placed Sir Humphry Davy's "Salmonia," after a few days' trout-fishing, not unjustly complained that Halieutes and his pupils always caught exactly the fish they wanted—which was not the case when he was fishing. It may perhaps be doubted whether the experiment would answer on this side the water.

But the familiar names of Dr. Coues and Miss M. A. Wright are a more than sufficient guarantee of the excellence of the ornithological part of the book, and to English students of bird-life it will be of real value. Here we have the actual every-day life of the birds most familiar to the New Englander, which very few of us can hope ever to study in their own homes. Many of them, of course, closely resemble our own, and a very few are identical with ours. But the great majority are new to us, and of these we learn very pleasantly from this book something that we could not have picked up except by crossing the Atlantic ourselves. The photographic illustrations are excellent; and there is a useful index and a classification of North American birds. But perhaps the best thing in the book is the account given by Mammy Bun, the negress, of the mocking-bird as she knew it in the Southern States.

W. WARDE FOWLER.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Worsted Test for Colour Vision.

IN NATURE of September 23 reference is made to the death of Dr. A. F. Holmgren, professor of physiology in Upsala University. "His attention," it is said, "was in the early seventies directed to colour-blindness, and in 1878, he published his well-known work on colour-blindness in relation to railways and the Navy, thus bringing to a practical issue the work long before begun by George Wilson, of Edinburgh (1855). This led him to the invention of his now well-known worsted test for colour vision."

May I be allowed to say that Prof. George Wilson, of Edinburgh (my brother) was, during a long series of investigations as to the nature and extent of this peculiarity of vision, constantly in the habit of using the "worsted test." In his work, "Researches on Colour Blindness" (published in 1855 by Messrs. Sutherland and Knox, Edinburgh, and Simpkin, Marshall, and Co., London), references very frequently occur to the use of wools as a colour test. On page 25 he says, "Dr. Y., aged 27, when requested to match coloured worsteds by daylight placed the full reds and greens together, but when the same skeins were placed before him by gaslight, he picked out the greens and placed them apart."

At page 44, while examining artillery soldiers at Leith Fort, he put into the hands of one man a bundle of coloured wools, from which he was to make a selection. The soldier was nervous, but retained with firm grasp a yellow skein of wool, putting it in the bundle containing red purple and red brown, with manifest perplexity at all the colours being alike. Page 40, soldiers in the Edinburgh garrison, known by previous experiments to be colour-blind, were closely watched while *from a heap of coloured wools* each one was asked to select first the red skeins and then the green, no notice being taken of the selection made till eight or nine skeins were set aside as red and the same number as green.

At page 70, 437 soldiers were asked to assort coloured papers, *wools*, and pieces of glass, and to place those of the same hue together. At page 77 a young Kaffir gentleman, whose knowledge of English was limited, was asked to match *Berlin wools* and tinted papers.

One advantage gained by making wools the test, was that many of the colour-blind have a specially keen sense of minute details, so that in seeing the same object more than once, they would recognise it by some small point or wrinkle or crease, scarcely perceptible to an ordinary observer. In the wool test this power was of no service to them.

I think from the examples quoted (and many more might be given), priority in making use of the "worsted test" may fairly be claimed for Prof. George Wilson. At many of the lectures given by him on this subject a diagram was exhibited, consisting of a square of calico to which were attached specimens of wools as selected by the colour-blind tested by him. In the course of time the colours faded, so as to lessen its value, and it was put aside.

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THE SOCIAL SYSTEM OF TERMITES.[1]

THOUGH more than a century has elapsed since Smeathman published the first careful account of Termitidæ, but few workers have substantially increased our knowledge of the subject. The reasons for this apparent apathy lie, indeed, on the surface. With few exceptions the Termites are tropical or sub-tropical in habitat; avoiding light, and living in vast concealed communities, their cryptic manner of life renders the task of observation extremely prolonged and arduous, while the multiplicity of forms in a single species, and the difficulties attending their preservation, have earned them little regard from the systematist.

The first marked advance towards unravelling the complexity of the Termite community was made by the great naturalist so lately lost to science, Fritz Müller. Following out Lespès' observations on the nymphs, he showed that a certain number of Termitidæ reach maturity and propagate without leaving the nest or acquiring the imaginal characteristics, and contended that the function of the swarming adults was not that of founding fresh colonies, but of furnishing royal pairs to pre-existing orphaned nests

His conclusions were supported by observations in nature, but were not made the subject of experiment; they are to be regarded as suggestions, which, however, approach very nearly to the truth.

The subject was taken up by Prof. Grassi in order to investigate the origin of the sterile castes, and the results of seven years' labour have been put forward in a monograph which, for the first time, places the nature of the Termite society beyond the reach of speculation. Intricate as the memoir is in the presentation of facts and inferences, it cannot but leave the reader with a profound sense of the perseverance, fertility in experiment, and deductive ability which it reveals.

Species of two genera, *Calotermes* and *Termes*, were studied, and success was largely due to the fact that it was found possible to keep small numbers of the former genus alive for long periods in corked test-tubes containing rotten wood. Careful observation thus became practicable, and by varying the number and kind of individuals introduced, their development and inter-relations could be studied.

Grassi's work on *Calotermes* shows that the eggs are of one kind and the newly-hatched larvæ undifferentiated, the caste distinctions arising after birth, and depending on the development of the genitalia. If this proceeds normally, the larva ultimately becomes a winged imago; if it is arrested at any period before the completion of the nymph-stage, the larva becomes a soldier; and finally, if it is precociously stimulated, a neoteinic form is produced, one, that is, which reaches sexual maturity without ever acquiring the imaginal characters. The insect remains plastic until the atrophic change of the genitalia has been set up; thus, a soldier-larva or soldier cannot be modified, but a nymph can be converted into a soldier possessing wing-buds (a "nymph-soldier"). These buds may be subsequently reabsorbed, so that a retrogression actually takes place. The colony is headed normally by a single king and queen derived from the perfect insects; should either or both be missing, their place is supplied by neoteinic "substitute" forms, which are then always produced if the society contains examples capable of undergoing this modification. An orphaned colony may be made to produce a much larger number of substitutes if subdivided into small societies than if kept together, and the same is true of the soldiers. This and similar observations go clearly to show that the modification of these individuals is no way predestined. The insects must possess the faculty for estimating a numerical ratio, and if the number of soldiers or royal substitutes is in excess of their needs, the supernumeraries are killed and eaten!

The colony of *Termes* is more complex and more difficult to study: it is similar in character except that it contains two sterile castes, soldiers and workers, and two kinds of neoteinic forms; one, the "complementary royal forms" are constantly present in large numbers as the ordinary reproductive members; the other, the "substitute forms," are developed on an emergency to supply their loss. In Sicily, according to Grassi, the winged imagos are entirely lost after swarming, and never give rise to fresh societies; but there is evidence that this remarkable example of natural wastefulness is not constantly exhibited in France. According to Marlatt, the closely-allied *Termes flavipes* of North America is known to reproduce by means of complementary forms alone.

Grassi holds that the caste-modifications are caused by variation in nutriment, and records a series of minute observations on the rather repulsive feeding-habits of these insects, made chiefly by his coadjutor Dr. Sandias. The staple food is wood, passed and repassed through the alimentary canal of several individuals; the society tolerates no waste, and everything of nutritive value, cast skins and dead bodies alike, is greedily devoured.

Newly-born larvæ and forms destined for sexual maturity are fed upon the saliva of their comrades, the largest amount being given to those which are becoming neoteinic; within forty-eight hours after its administration they become altered, acquiring ocular pigmentation and a translucent white appearance.

It is therefore contended that sexual development is directly stimulated by the saliva taken as food; but a disturbing factor has had to be eliminated. The alimentary canal of most Termites teems with protozoa, which bring about the dilatation of a cæcal ampulla so as to fill the greater part of the abdomen. These protozoa disappear under the influence of a salivary diet, and the question has arisen whether the resulting diminution in size of the ampulla may cause the gonads to ripen. Grassi answers this in the negative. All Termites lose their parasitic protozoa at the time of moulting, and by taking advantage of this circumstance he has been able to keep colonies alive for a month or more entirely free from protozoa. A few examples only in these colonies became neoteinic; and it is therefore clear that the saliva is one, if not the only, necessary factor in bringing about sexual maturity.

No light has been thrown on the causes which, in Termes, lead to the differentiation of the soldier from the worker; but it may be reasonably inferred that they are also due to differences in nutrition.

As already indicated, the results of this research are directly opposed to the hypothesis that special ova or special sets of "determinants" exist for the various castes in Termitidæ. It is not necessary here to dwell upon this point, which, it may be recollected, has been dealt with conclusively by Mr. Herbert Spencer in his controversy with Prof. Weismann (*Contemporary Review*, October 1894).

The means by which the special characters of the sterile castes are inherited is a matter which has caused Prof. Grassi some trouble. In the original memoir he appears scarcely to have made up his mind on the point; but in a footnote appended to the English translation he puts forward the supposition previously advanced by him in the case of bees, that it is to be interpreted by the exceptional occurrence of soldiers and workers capable of oviposition. This view is supported by the discovery of a "nymph-soldier" with well-developed ovarian tubes. Much more evidence is still required as to the occasional existence of fertile soldiers and workers, especially in

[1] "The Constitution and Development of the Society of Termites, &c." By Prof. B. Grassi and Dr. A. Sandias. English translation in the *Quarterly Journal of Microscopical Science*, vols. 39 and 40; with five plates.

species, if such exist, in which the caste distinctions are still incipient. If it can be shown that the evolution of caste characters is in any way anterior to the loss of fertility, the difficulties of interpretation will disappear; at present the evidence points to the fact that owing to qualitative changes in nutrition, rather than simple malnutrition, an atrophy of the sexual organs is set up which is correlated with a hypertrophic modification of other structures, by a deflection, so to speak, of the nutritive stimulus.

Many neoteinic forms show no trace of wings. If the termite colony were headed by such forms only, the phenomenon, as Grassi points out, would occasion no surprise, but all valid evidence would be wanting that the species had ever possessed wings. This leads to the admission on his part that there is no proof that all existing wingless insects may not be descended from winged ancestors, and in the absence of such a proof he is led to reject Brauer's division of Insecta into Apterygogenea and Pterygogenea.

Space forbids any reference to the full account of the social life, habits and instincts of the species which Prof. Grassi has studied. Their intelligence, though remarkable, is far inferior to that of ants, and may be profitably contrasted therewith. Whilst referring to this subject, it may be worth while to call the attention of those interested in animal psychology to two lately-published pamphlets on the subject, particularly that on the psychology of ants,[1] by Father Wasmann, a most careful observer and thorough student of animal intelligence.

One practical result of Grassi's work requires mention. An isolated group of ten or a dozen Termites, containing any forms which have not begun to undergo the atrophic changes induced in the sterile castes, is capable of converting such forms into reproductive individuals; and the little society, thus started, possesses the power of multiplying into a large colony.

It is therefore hopeless to attempt the extermination of Termites merely by the destruction of the kings and queens. W. F. H. BLANDFORD.

PERIODICAL COMETS.

THE number of comets of short period which are expected to return to perihelion during the next two years is remarkable. In 1898 the following comets are due:—Pons-Winnecke (April), Encke (May), Swift, 1889 VI. (June), Wolf (June), Tempel, 1867 II. (September); in 1899, Denning, 1881 V. (January), Tempel, 1866 I. (March), Barnard, 1892 V. (April), Tuttle, 1858, I. (May), Holmes (May), and Tempel 1873 II. (July). In addition to these, 1898 may possibly witness a return of Biela's comet, last seen in 1852, and of Coggia's, 1873 VI.; but these are doubtful, and the prospect of re-observing them appears to be very limited. Thus there are thirteen known comets which may present themselves for detection, but several of them will be enabled to elude observation in consequence of their unfavourable position, and in one or two cases the objects may escape owing to the uncertainty now existing as to the exact periodic times.

Apart from the large number of interesting comets which are likely to be visible, several fine meteoric showers will probably occur, for the Leonids are due in considerable abundance on November 14, 1898, 1899 and 1900, while the Andromedes ought to reappear on November 23, 1898. Both for the cometary and meteoric observer we are, therefore, entering upon a period very prolific in important phenomena.

During the first quarter of the present century the number of cometary discoveries averaged about one per annum. The present average is about five, including periodical comets, which represent no small proportion of the whole. The rapid increase, during the last twenty years, in the number of comets of short period is very striking, and proves not only that these bodies are exceedingly plentiful, but also that the field of discovery is not nearly exhausted. They belong to the Jovian family, with periods ranging from five to nine years. Encke's comet furnishes rather an exceptional case, the period being only 3·3 years, and considerably shorter than that of any other known.

Perhaps it may be interesting to make a brief seriatim reference to the expected comets of the next two years:—

Pons-Winnecke.—This comet, due in April 1898, was well observed at its last return to perihelion in June 1892. The ensuing return will not be so favourable, as the comet will be much more distant from the earth, and visible only in the morning sky. This return will be much the same as in 1875, four periods of the comet being equal to twenty-three years; thus perihelion occurred on June 30, both in 1869 and 1892.

Encke.—Returns in May 1898. The comet will not be so well placed, owing to its southern position, as at its last return, when it was quite conspicuous in December 1894 and January 1895. Observations may be made satisfactorily from the southern hemisphere after the perihelion passage, as in 1832 and 1865, when the comet was discovered in June. At intervals of thirty-three years (=10 revolutions of the comet) it comes to perihelion at nearly same times as before, and its apparent path in the heavens is repeated.

Swift, 1889 VI.—Considerable uncertainty is attached to the orbit of this comet. Hind deduced a period of 8·534 years, which would bring the comet back at midsummer 1898; but Coniel has more recently determined the period as 8·92 years, with an uncertainty of 0·9 year. If this object is redetected, it will probably be picked up accidentally by some one engaged in comet-seeking. The most favourable returns are those when it reaches perihelion in October or November.

Wolf.—This comet, which will reach its perihelion in June 1898, was favourably observed in 1884 and 1891; but in 1898 the conditions are not nearly so good. The following ephemeris for the next return is by A. Berberick (*Ast. Journal*, 253).

Date.			R.A. h. m.		Dec. ° ′		Light.
1898.—June	3	...	1 42·3	...	+18 18	...	1·7
July	5	...	3 18·3	...	+19 43	...	2·1
Aug.	6	...	4 49·3	...	+16 51	...	2·3
Sept.	7	...	6 4·9	...	+10 2	...	2·4
Oct.	9	...	6 56·9	...	+ 0 38	...	2·4
Nov.	10	...	7 17 9	...	− 9 21	...	2·4
Dec.	12	...	7 4·1	...	−16 20	...	2·1
1899.—Jan.	13	...	6 34·1	...	−16 31	...	1·4

(Brightness May 1, 1891 = 1.)

Dr. Berberick remarks that later returns of the comet will be unfavourable. Seven of its revolutions are equal to three of Jupiter, and a second approach of these bodies will occur in 1922–23, depriving us perhaps of the sight of the comet for a long time, if not for ever.

Tempel, 1867 II.—Comes to perihelion in September 1898. This comet was re-observed in 1873 and 1879, but has not been seen since, though it has twice returned to perihelion in the meantime. The conditions in 1898 are not very good. The periodic time was about six years in 1867, 1873 and 1879; but perturbations by Jupiter have considerably lengthened the period according to Gautier. It is most important that the comet should be redetected if possible.

Denning, 1881 V.—Returns to perihelion in January 1899, but under circumstances not nearly so favourable as in 1881. In January and February its distance from the earth will be about 100 millions of miles, and about

[1] "Instinct und Intelligenz im Thierreich," and "Vergleichende Studien über das Seelenleben der Ameisen und der höhern Thiere," by Erich Wasmann, S.J. (Freiburg, 1897).

the same as when last seen in the Strassburg refractor of 20 inches aperture, on November 24, 1881. In view of the doubts prevailing as to its exact period, it is questionable whether it will be redetected in 1899. At its following return in 1907 the comet ought to be conspicuously visible for some months, as it will be comparatively near to the earth, and the favourable return of 1881 will be repeated, three periodic revolutions (1 = 8·687 years) of the comet being equal to twenty-six years. At its last return in 1890 May, the position of the comet was such that it never approached within 150 millions of miles of the earth, and thus it entirely escaped observation.

Tempel, 1866 I.—This comet is due in the spring, but it will be separated from the earth by a much wider interval than in 1866. Its favourable returns are those when perihelion occurs in about November or December. If the comet has the same periodic time as its associated meteor shower (the Leonids), then it is well visible at one return only out of every three, and its next favourable apparition will occur in 1965–6.

Barnard, 1892 II.—The period of this faint comet (discovered by photography) is somewhat doubtful. Hind gave 6·64 years, Krueger 6·309, Porter 6·18, and Coniel 6·52. The comet will probably return to perihelion in the spring of 1899, when it will, however, be invisible, being obliterated in the sun's rays. When the comet reaches its perihelion in the autumn it can be well observed.

Holmes.—This comet returns to perihelion in April 1899 according to Zwiers, the probable error being 0·72 day. His orbit was derived from 600 observations. Dr. Kohlschütter has also given a definitive orbit for this comet, his periodic time for it being 2520·829 days, while Zwiers gives 2521·2 days. The latter, after allowing for perturbations by Jupiter and Saturn, gives April 27·97 as the date of perihelion, and his ephemeris for 1898, as abridged, is as follows:—

Greenwich Noon, 1898.

	R.A. h. m.	Dec. ° ′
Feb. 16	16 26	−42 7
Mar. 18	16 52	−45 44
April 17	17 0	−49 20
May 17	16 41	−51 49
June 16	16 5	−51 1
July 16	15 46	−47 10
Aug. 15	15 56	−43 2
Sept. 14	16 31	−39 55

The comet must therefore be looked for at southern observatories, in 1898; it will be well placed for northern observers in 1899.

Tuttle.—This comet, first discovered by Mechain in 1790, and re-observed by Tuttle in 1858, was also seen in 1871 and 1885. It belongs to Saturn's comet family, its orbit, at aphelion, being just outside that of Saturn. The conditions are not favourable for seeing the comet at the ensuing return in the summer of 1899, as its longitude of perihelion is 116°, and perihelion distance 1·03, or about 3 millions of miles outside the earth's orbit. The comet is therefore best visible when it comes to perihelion at the end of January, the earth and comet being then on the same side of the sun, and only a few millions of miles distant from each other.

Tempel, 1873 I.—Returns early in July 1899, and will be observed under pretty good conditions, the earth and comet being on the same side of the sun. The comet will be visible during the whole night, and is likely to be as successfully observed as in 1873, when it was first discovered, for five of its periods of 5·20 years are equal to twenty-six years.

No doubt some of our largest telescopes will be employed in the redetection of these objects as they severally return to perihelion. In recent years the diligence of observers has been the means of increasing the number of periodical comets at the average rate of one per year, and this increase will probably be maintained, if not exceeded, in the future.

It might be supposed that comets returning to the sun at comparatively short intervals would soon be all detected; but when the circumstances are considered, it will be seen that this state of things will be never realised. The comets of short period are faint objects, and often pass their perihelia under conditions which render them totally invisible. Thus De Vico's of 1844 was computed by Brünnow to have a period of 5·469 years, but it was not seen again until 1894, though during the fifty years it had returned unobserved on eight occasions. Pons's comet of 1819 was assigned a period of 5·618 years by Encke, but it was not seen at any of the six subsequent returns. Winnecke, however, in 1858, at its seventh return, picked it up accidentally. Mechain's comet of 1790, with a period of 13·8 years, must have returned in 1803, 1817, 1830 and 1844, but it eluded re-observation until Tuttle recovered it in January 1858.

Most of the periodical comets at perihelion are outside the earth's orbit, and hence it follows that they escape observation unless the earth is on the same side of the sun as the comet. As an instance of the favourable presentation of a comet, that of 1894 I. may be alluded to. Its perihelion is 14 millions of miles outside the earth's orbit, and is in longitude 130½°, which it reached on February 9. Now the earth was in longitude 140° at the same time, so the comet was nearly in opposition and visible under the most favourable circumstances during the whole night.

Some comets, as Tempel-Swift's, are only perceptible at alternate returns; others are not well visible except at intervals after two, three, or four returns.

Another circumstance which will prevent our exhausting the discovery of these objects, is that the planet Jupiter frequently introduces disturbances into their motions, and possibly into the physical conformations of the short period comets. He appears, also, capable of effecting new captures, and thus bringing these bodies into permanent membership of the solar system. The Jovian family of comets is already a numerous one, and is probably increasing, though some of the objects which owe allegiance to Jupiter are in process of disruption and gradual dispersion, and seem likely in the end to lose their visible character, as compact bodies, to form meteoric streams with the residue of their material. Biela's comet has not been seen for forty-five years, though it ought to have returned six times in that interval, and was one of the earliest discovered, as well as one of the best known, of the periodical comets. It will probably never be seen again as a comet, though its associated meteors will be displayed in November 1898, and in future years at periods conforming with the time of revolution of the parent comet.

We must, however, not be too hasty in assuming the collapse of known comets, for experience has taught us that they may reappear when least expected. The visible return of De Vico's comet of 1844, after being unseen for fifty years, and of Pons's comet of 1819, after an invisibility of thirty-nine years, shows us what is possible. Brorsen's comet, which escaped observation in 1884, 1890 and 1895, is supposed to have disappeared like Biela's, but a small comet may be swept up at some future time which will exhibit a similarity of elements to that of the missing Brorsen sufficient to prove the actual identity of the two objects.

The distribution of the aphelia of periodical comets near the orbits of the major planets is not the least interesting feature connected with these bodies. But it is perhaps a little remarkable that though Jupiter's family has enormously increased in recent years, yet the other groups have received very few, if any, additions, though a large number of new comets have been discovered.

W. F. DENNING.

THE PROGRESS OF THE STEAM TURBINE.

THE earliest notices of heat engines are found in the "Pneumatics" of Hero of Alexandria, which dates from the year 200 B.C. One of the steam or motive power engines there mentioned is the Æolipiles, a steam reaction engine consisting of a spherical boiler pivoted on a central axis beneath which is placed a flame. The steam escapes by bent pipes facing tangentially in opposite directions at opposite ends of a diameter perpendicular to the axis.

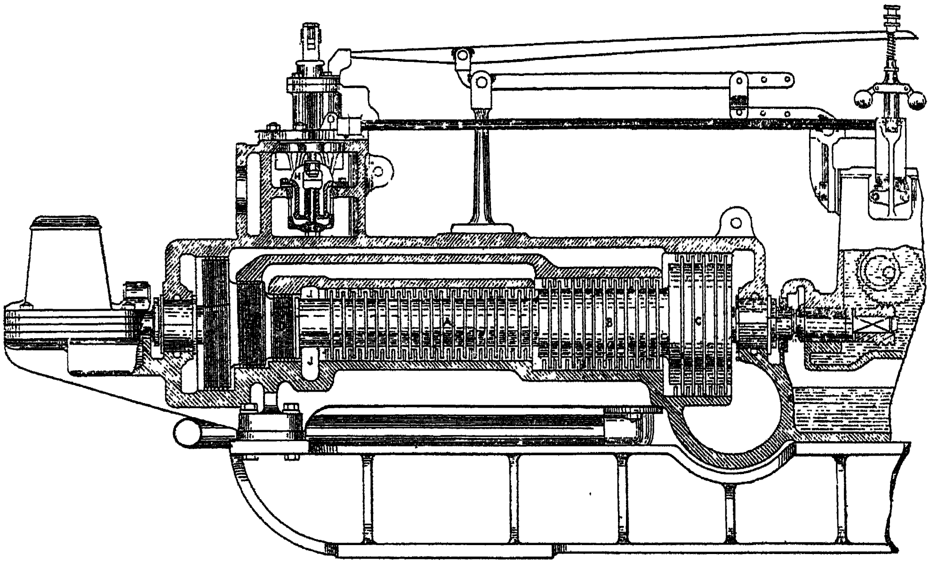


FIG. 1.—Sectional view of a Compound Turbine, showing the turbine blades and also the steam admission valve and bearings, as well as the governor gear.

The globe revolves by reaction of the escaping steam, just as a Barker mill is driven by escaping water.

No practical or useful steam engine appears to have been made on this or any analogous principle till the year 1884, though many attempts seem to have been made on more or less crude lines; meantime the piston engine of Papin, Savery, Newcomen, and Watts has been developed during the last 200 years, and by its general use has revolutionised the means of transit and tended to vastly increase the productive power of labour generally.

The want of a fast running engine for driving dynamos presented an immediate field for the application and development of a suitable steam turbine engine. The advantages of a steady running engine having no reciprocating parts, of small size and extreme lightness, were sufficiently obvious provided that fairly economical results as to steam consumption could be realised.

The highly economical results obtained from water turbines gave hopes that, provided suitable conditions could be arranged, similar efficiency would be obtained with steam as with water; and assuming this to be possible it would naturally follow, after taking all other losses into account, that the steam turbine would be more economical in steam than the piston engine.

These possibilities, and the interest of applying a practically new method for motive-power purposes, led the Hon. C. A. Parsons to build an experimental engine of ten-horse power coupled directly to a dynamo.

For practical reasons it was, however, necessary to keep the speed of rotation of the turbine as low as possible, and also to construct the dynamo to run as fast as possible, so as to couple the turbine directly to it; and in order to obtain the necessary conditions for steam economy the turbine was made what is called compound, or, in other words, a series of successive turbine wheels were set one after the other on the same spindle, so that the steam passing through them one after the other, the fall in pressure being spread over the series of turbines should be gradual, and the velocity of the steam nowhere more than was desirable for obtaining a high efficiency for each turbine of the series.

The turbine motor consists of a cylindrical case with rings of inwardly projecting guide blades, within which revolves a concentric shaft with rings of outwardly projecting blades. The rings of blades on the cylinder nearly touch the shaft, and the rings of blades on the shaft lie between those on the case, and nearly touch the case. It will be seen, on referring to Fig. 1, that there is left between the shaft and the case an annular space, which is filled with alternate rings of fixed and moving

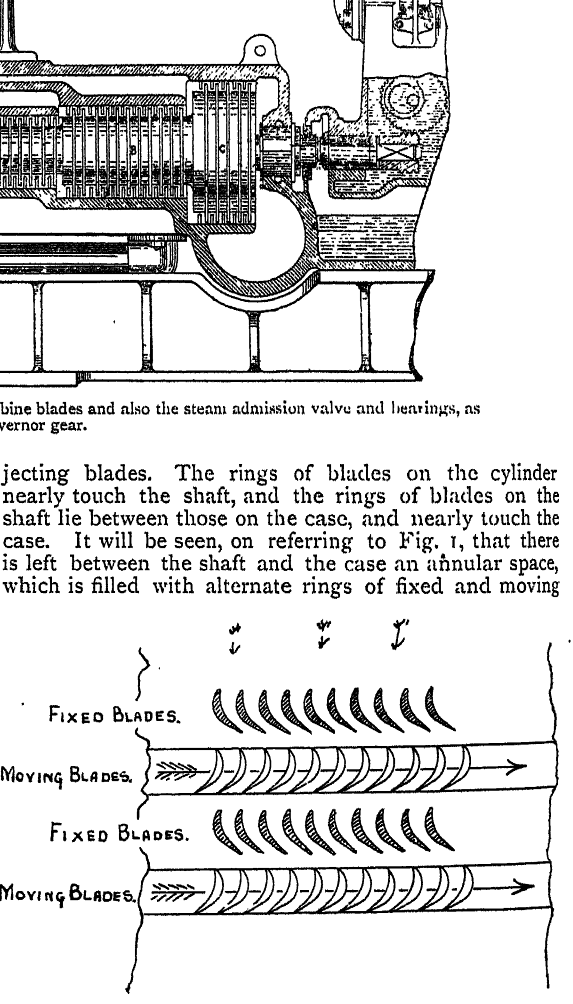


FIG. 2.—Section through blades in annular space between shaft and casing showing relative positions of fixed guide blades and moving blades. The three arrows at the top indicate the direction of motion of the entering steam.

blades. Fig. 2 shows one form of blades which is used. Steam entering at J (Fig. 1) passes first through a ring of fixed guide blades, by which it is projected in a rotational direction upon the succeeding ring of moving blades, imparting to them a rotational force; it is then thrown back upon the succeeding ring of guide blades, and the

reaction increases the rotational force. The same process takes place at each of the successive rings of guide and moving blades. The energy to give the steam its high rotational velocity at each successive ring is supplied by the drop in pressure, and the steam expands gradually by small increments. In a moderate-sized turbo-motor there may be from thirty to eighty successive rings, and when the steam arrives at the last ring the expansion has been completed. On the left side of the steam inlet J are the driving or rotating pistons, which are fixed to and rotate with the shaft. On their outsides are grooves and rings, which project into corresponding grooves in the case. By means of the thrust bearing of the motor the longitudinal position of the shaft is adjusted and grooves and projecting rings kept nearly touching, so as to make a practically tight joint. The object of these pistons is to steam balance the shaft and relieve end pressure on the thrust bearing. Fig. 3 shows a 350 kilowatt turbo-alternator, thirteen of which size are now at work in the London stations.

With compound condensing turbines a steam efficiency comparable with the best compound or triple expansion condensing engines was at length reached, and it was then resolved to test the application of the turbine to the propulsion of ships, for which purpose it seemed well suited, provided that as good an efficiency could be obtained from fast running screw-propellers as with ordinary ones, and to test the system it was determined to build the *Turbinia*, which is 100 feet in length, 9 feet beam, and 44½ tons displacement. One compound condensing turbine engine of 2000 I.H.P. was at first fitted, but it was found that long before this power was developed the screw began to tear the water, forming vacuous spaces and vortices behind the blades, and causing great loss of propulsive effect. The single large engine was then replaced by three separate ones, high pressure, intermediate pressure, and low pressure, each driving a screw shaft at the same speed of rotation as before; but the blade area was by these means trebled, and this trouble ceased. The efficiency of the screws approached closely to the best results of ordinary screws. The *Turbinia's* engines are similar to those for the driving of dynamos described, but they are necessarily larger and of lighter construction, and the expansion of the steam is carried to 170-fold at full speed. Prof. Ewing's tests have shown a consumption of 14½ lb. of steam per I.H.P. at a speed of 32¾ knots, and the maximum speed so far obtained has been about 35 knots.

It is anticipated that this turbine engine can be successfully applied to all the faster class of vessels, including those of the largest size; in fact, it appears that the relative advantages are greatest in the largest sizes.

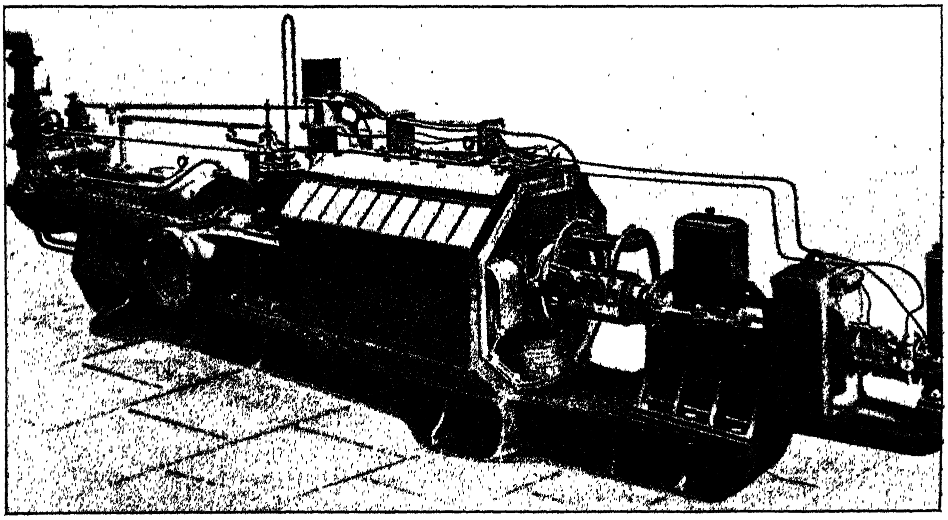


FIG. 3.—A 350-kilowatt Alternator and Turbine.

NOTES.

THE new Government Laboratory, which has been about two years in course of erection, is now completed, and will be formally opened to-morrow (October 1). We hope to be able to give a description of the building in our next issue.

THE Paris correspondent of the *Times* states that an anniversary service was held on Tuesday at the Pasteur Institute in honour of the great investigator. A number of his disciples and the members of his family who are in Paris assembled in the crypt of the Institute at his tomb, and placed upon it garlands of flowers from the Garches gardens. The subscription for the Pasteur monument now exceeds 300,000 francs.

AN epidemic of typhoid fever has broken out at Maidstone, Kent. More than nine hundred cases have been notified, and up to Tuesday night twenty-one deaths from the disease had occurred since the beginning of the outbreak. The epidemic is due to polluted water, and is confined to the area of the town supplied with water from springs at Farleigh, all of which have been condemned by the medical officer of health.

IT is much to be regretted that the splendid male Giraffe, presented to the Queen by the Chief Bethoen, of Bechuanaland, died so soon after reaching this country. The difficult task of bringing it home was entrusted by the Colonial Office to the Zoological Society, who selected for the work one of the most experienced men in Europe in moving large living animals—Herr Windhorn, of Alfeld. The Giraffe was led from Kanya to Lobatsi by road, and safely lodged at the railway station in a box, which had been specially constructed for it at Cape Town. It was placed on board the s.s. *Roslin Castle* (in which a free passage had been most liberally granted to it by Sir Donald Currie), and left Cape Town on September 1. The passage was a stormy one, and after the first week the Giraffe declined to eat anything but bread. A few days later it left off feeding altogether,

in spite of every attempt of its experienced keeper to induce it to eat. It was therefore, on reaching London, nearly dead from exhaustion, and only lived for half an hour after its arrival in the Regent's Park, where it was proposed to keep it for the winter. This event is the more to be lamented, as the fine young female already in the Society's Gardens (which was also brought to England from the Cape by Herr Windhorn) thus remains still without a mate, and there is at present little prospect of obtaining one.

AMONG the prizes awarded by the Institution of Civil Engineers for the session 1896–97 are the following :—The Howard prize of fifty guineas to Mr. H. Bauerman, in recognition of his work on the metallurgy of iron. For original papers presented to the institution, Telford medals, with premiums of books or instruments, to Messrs. H. A. Humphrey, for "The Mond Gas-Producer Plant and its Application"; to Colonel Pennycuick, R.E., for "The Diversion of the Parivar"; to Mr. E. C. Shankland, for "Steel Skeleton Construction in Chicago"; to Mr. Dugald Drummond, for "High Pressure in Locomotives"; and to Mr. Thomas Holgate, for "The Enrichment of Coal Gas." George Stephenson medals and Telford premiums to Mr. Cruttwell, for "The Tower-bridge Superstructure," and to Prof. Unwin, for "A new Indentation Test for Determining the Hardness of Metals." Watt medals and Telford premiums to Messrs. Hay and Fitzmaurice, for their joint paper on "The Blackwall Tunnel." This year marks the first award by the Institution of the medals named after Joule, the discoverer of the mechanical equivalent of heat, and Mr. James Forrest, whose long service as secretary and the care devoted by him to fostering the student class, have on his retirement been commemorated by the foundation of a medal. The presentation will be made at the opening meeting of the new session on November 2.

THE deaths are announced of Dr. August Mojsisovics, Edler von Mojsvar, professor of zoology and comparative anatomy in the University of Gratz; Mr. Theodore Lyman, honorary member of the National Academy of Sciences; and Dr. Welcker, for some years professor of anatomy in the University of Halle.

PROF. JOHN MILNE has shown us the photographic tracings of two well-marked earthquakes, recorded last week by his seismographs at Shide, in the Isle of Wight. The times of the disturbances are September 20, 7.30 p.m., and September 21, 5.30 a.m. The duration of each disturbance at Shide was about three hours, and the preliminary tremors extended over about forty minutes, from which facts Prof. Milne concludes that the place of origin was at least six thousand miles distant.

MR. N. L. BRITTON has been elected President, and Mr. J. C. Arthur Vice-President, of the Botanical Society of America for the coming year.

WE learn from the *Botanical Gazette* that the Smithsonian Institution, Washington, has undertaken an important work in bringing together all possible material bearing on the medicinal uses of plants in the United States. Dr. V. Havard is chairman of the commission for this purpose.

MR. WILLIAM WESLEY WOOLEN, of Indianapolis, has announced his intention of presenting to that city a tract of land, consisting of fifty-six acres, for the purpose of establishing a botanic garden and an ornithological preserve.

PROF. J. P. O'REILLY sends us some extracts from a work on Morocco ("An Account of the Empire of Marocco," by James Grey Jackson, 1814), containing an account of the use of olive oil as a remedy for a form of plague which depopulated West Barbary in 1799–1800. The oil was used to anoint the skin, either before or after infection. Prof. O'Reilly points out that the ordinary olive oil of the Levant and of Spain is not the pure clarified oil we know of in this country, but a green and generally more or less rancid oil produced in a coarse way from all sorts of fruit, unsound as well as sound.

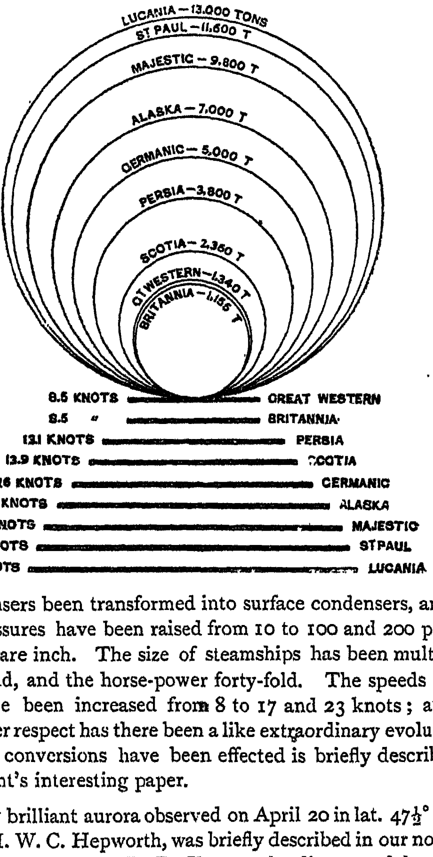
THE October number of *Science Progress* will contain articles on "Some Physiological Aspects of Hypnotism," by Prof. F. Gotch, F.R.S.; on "Artificial Flight," by Prof. G. H. Bryan, F.R.S.; on "Progress in the Study of Variation," by Mr. W. Bateson, F.R.S.; on "Blood and the Identification of Bacterial Species," by Dr. Grunbaum; on "The Fauna of the Great African Lakes," by Mr. J. E. S. Moore.

DURING the past summer full advantage has been taken of the facilities for research afforded by the Plymouth laboratory of the Marine Biological Association. Prof. Weldon has carried out an interesting experimental inquiry into the selective action of different conditions in the case of *Carcinus mænas*. Mr. S. D. Scott has studied the physiology of excretion in certain Ascidians, Dr. Lubbock the anatomy of various fishes. Dr. G. Duncker, of Kiel, is at work upon the racial characteristics and variation of Pleuronectids and other fishes; Mr. Taylor, upon Polyzoa; Messrs. E. T. Brown and Jenkinson, of University College, London, upon Medusæ and larval Crustacea respectively; Messrs. Bedford and Lanchester, of King's College, Cambridge, upon the development of *Myriothela* and general marine zoology. Mr. W. I. Beaumont has been studying more especially the Nudibranchiate Mollusca and Nemertinea, and some rare captures have rewarded his exertions, notably several specimens of *Hancockia* and large *Lomanotus*. Mr. Brebner, of University College, Bristol, and Mr. A. H. Church, of Oxford, have devoted much attention to the collection and study of marine algæ. In spite of the inclemency of the weather during August, the steamboat *Busy Bee* has been in constant requisition throughout the summer. Under Mr. Holt's charge a prolonged visit was paid in July to Falmouth, where Mr. Rupert Vallentin and Mr. J. T. Cunningham assisted the staff, and much valuable material was accumulated. The rare dragonet *Callionymus maculatus* and the interesting Anthozoan *Gonactinia prolifera* were obtained during this cruise. Trawling expeditions under Mr. Holt have also been made to Exmouth and Dartmouth, in addition to the routine work in the neighbourhood of Plymouth. Mr. Garstang has returned from Toronto, and has resumed his investigation of the racial characters and variation of the mackerel, for which purpose a large number of fish has been received from H.M. Inspectors of Irish Fisheries. In connection with the food-supply and migrations of pelagic fishes, Mr. Garstang is also investigating the seasonal changes and distribution of the plankton, and has brought back with him two series of collections of the surface plankton of the North Atlantic, obtained during his recent voyages from Liverpool to Quebec *viâ* the North of Ireland, and from Philadelphia to Queenstown along the edge of the Gulf Stream. Interesting results are expected from the comparison of these collections of "pump-plankton." The Marine Biological Association's exhibit, which proved so attractive a feature of the recent fisheries exhibition at the Imperial Institute, has been returned to the laboratory, and has been temporarily set up again in the students' lecture-room.

PROF. R. C. CARPENTER, professor of engineering science in Cornell University, has (says *Engineering*) been conducting an elaborate set of experiments on bicycle friction which have led him to the conclusion that no form of gearing can possibly equal the best chain for efficiency and durability. With such the frictional loss has been found to be between $\frac{1}{2}$ and $\frac{3}{4}$ per cent. of the total power transmitted, this result being obtained with a chain which had previously been ridden more than 2000 miles with a rider weighing about 14 stone. With some other

chains less well constructed, a greater loss has been found, the friction lying generally between 2 and 5 per cent.; the maximum shown, even by an old chain which did not fit its sprocket properly, was under 10 per cent. No bevel gears as yet constructed give as good results as these, and Prof. Carpenter concludes that with even the best bevel-geared bicycles the loss must be four times as much as with the ordinary chain, and six times as much as with the best chain. Moreover, as has been previously pointed out, gear wheels to work well must be in very accurate adjustment with each other, whilst with a chain no such careful fitting is required.

THE current number of *The Engineering Magazine* contains an instructive illustrated article, by Mr. Ridgely Hunt, on fifty years of advance in marine engineering. The accompanying diagram, reproduced from our contemporary, shows at a glance the increase of tonnage and speed during the last half-century. In this period iron and steel have supplanted wood, and, says the author, "engines have advanced from simple to compound, and then to triple-expansion; so, too, have paddle-wheels been discarded for single-propellers and for twin-propellers; so, too, have single rectangular boilers with one flue, been replaced by several boilers, cylindrical, and with many tubes; so, too, have



jet condensers been transformed into surface condensers, and the steam pressures have been raised from 10 to 100 and 200 pounds to the square inch. The size of steamships has been multiplied twenty-fold, and the horse-power forty-fold. The speeds of the ships have been increased from 8 to 17 and 23 knots; and in every other respect has there been a like extraordinary evolution." How the conversions have been effected is briefly described in Mr. Hunt's interesting paper.

A VERY brilliant aurora observed on April 20 in lat. 47½° S., by Captain M. W. C. Hepworth, was briefly described in our notes on June 24 (p. 183). Mr. T. F. Claxton, the director of the Royal Alfred Observatory, Mauritius, sends us an account of magnetic disturbances apparently connected with the aurora display. He says that on the day of the aurora a rather large magnetic disturbance was recorded at the observatory. "From June 20d. 9h.–19h. the horizontal force decreased ·01578 m.m.s. units. From 20d. 12½h.–19h. the vertical force increased ·00336 m.m.s. units, and the declination, from 20d. 9½h.–13h., decreased 9'·2, and from 13h. to 19h. increased 7'·0. The most active period was from 20d. 17h.–20h. The magnets were quiet from 21d. 0h.–23d. 10h. 16m., when a sudden decrease of horizontal force, vertical force, and declination occurred to the extent of ·00258, ·00056 m.m.s. units, and 1'·0 respectively. In horizontal force the decrease continued till 23d. 21½h., and amounted to ·01204 m.m.s. units, while the disturbance in vertical force was very small."

THE report of the Central Meteorological Office of France for the year 1896, shows a large amount of work performed, and is very creditable to the staff of that institution. One of the principal services rendered consists in predicting the approach of storms for one or two days in advance. Out of thirty-four storms which reached the French shores, thirty-one, or 91 per cent., were foretold. This satisfactory result is, to a considerable extent, due to the fact that the great majority of these disturbances cross the British Isles, notice of which is regularly telegraphed to Paris by the Meteorological Council. The number of telegraphic reports received daily amounts to 167, some of which are from America, and include observations received from the fast trans-Atlantic steamers. In the department of climatology, reports are received from 211 places, in addition to a very large number of rainfall stations, and the results and discussions are published in three large quarto volumes yearly. In addition, monthly returns are received from about fifty foreign stations, as well as a large number of ships' logs. Particular attention is also paid to the collection of observations made at mountain stations, as well as by means of balloons and kites. The observation of clouds has formed a special feature during the past year; between July 1896 and April 1897, M. Teisserenc de Bort has taken no less than 2500 photographs of clouds at his observatory at Trappes, and by this means the heights of 750 have been determined.

WE have already had occasion to direct attention in our columns to the ingenious experiments conducted by Messrs. Nuttall and Thierfelder on the possibility of animal life being carried on in the absence of bacteria in the digestive tract; the third memoir on this subject by these gentlemen has now appeared in the *Zeitschrift für physiologische Chemie*, Bd. xxiii., 1897. In their previous experiments guinea-pigs were selected as subjects for experiment, but it not unnaturally occurred to the authors that chickens would be more suitable, inasmuch as they might remove some of the great difficulties which attend the procuration of the former animals in an aseptic condition from their birth. Accordingly, a few hours before the chicken was due to be hatched some eggs were carefully washed outside with corrosive sublimate and hydrochloric acid, to remove all external germ-life, and were then placed in the sterile apparatus devised by the authors, and employed in their previous experiments. But, despite the most careful manipulations, bacteria obtained access to the apparatus and spoilt the observations. There was only one conclusion to be drawn, which was that the egg-shells of the hatched chickens were responsible for the mischief. Accordingly careful examinations of eggs were made, with the result that in every instance bacteria were found on the inside of the shell. The authors conclude that bacteria are present in the oviduct before and during the formation of the shell, and become attached to the membrane of the shell. This unlooked-for and, from the experimental point of view of the investigators, unpropitious discovery has led to the abandonment of chickens for the purpose of these observations, and the authors do not announce any further intention of pursuing their interesting researches.

CULTIVATORS in many regions of the globe will be interested in what appears to have been a successful series of locust-destroying experiments carried out in Natal, a report of which has been published in that colony as a Government notice. From a note in the *Times*, it appears that all attempts to suppress the

locust scourge there have proved only partially successful, with the exception of the plan of poisoning with arsenic, which, it is asserted, has met with absolute and unqualified success. The mixture used is prepared by heating four gallons of water to boiling point, and then adding 1 lb. of caustic soda. As soon as this is dissolved, 1 lb. of arsenic is added, after which the liquid is well stirred and boiled for a few minutes, care being taken that the fumes are not inhaled. When required for use, half a gallon of the liquid is added to four gallons of hot or cold water, with 10 lb. of brown sugar. A still better preparation is made by adding half a gallon of the poisonous liquid to five gallons of treacle. Maize-stalks, grass, &c., dipped in the mixture, are placed along the roads and in the fields, and the material can also be splashed with a brush upon anything which the locusts are known to have a liking for. Attracted by the odour of the sugar or treacle over a distance of as much as 100 yards, the locusts will eat of the mixture and die. These are eaten by other locusts, and in a few days' time the ground may become strewn with the dead bodies of the insects. With ordinary care no risk of poisoning any human being is incurred, whilst the small quantity of the material on a piece of grass or maize-stalk is said to be insufficient to injure stock of any kind—fowls have been known to feed without injury on the arsenic-destroyed locusts. The evidence adduced indicates that "hoppers," however numerous, can be destroyed in a few days, and the crops thus saved from their ravages.

Petermann's Mittheilungen promises accounts of much important geographical work recently done in Asia. M. de Déchy has explored some interesting and little-known districts of the Caucasus. Dr. Sven Hedin is to publish (in the *Mittheilungen*) a series of articles on the Mustagh-ata, the Deserts of Eastern Turkestan, the Lob-Nor problem, and on Northern Tibet. The Hungarian geologist, Dr. Eugen von Cholnoky, has made some progress with an investigation of the hydrography of the great plain of China.

SIGNOR FRANCESCO CHINIGO contributes, to the *Bollettino della Società Geografica Italiana*, a note on the salt deposits of Lungro, on the slope of the Calabrian Apennines. The deposits have been worked to a depth of 220 metres, and probably extend to a much greater distance below the surface. Analyses show a composition of 97·7 per cent. of sodium chloride, the principal other constituent being sodium sulphate. The output is at present much restricted, chiefly on account of deficient railway communication, but there is no real obstacle to prevent these deposits supplying the whole of Italy with salt of the highest quality.

THE *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains a short summary, by Dr. Carl Sapper, of available information about the first campaigns of the Spaniards in Northern Central America. The material at hand is in many respects unpromising, many accounts are directly contradictory, and there are traces of much priestly interference with the documents; but a good deal can, nevertheless, be made out with fair chances of accuracy. Dr. Sapper shows on a sketch map the courses of Francisco Hernandez (1517), of Juan de Grijalva (1518), and of Ferdinand Cortes (1519) by sea, and the land routes of Ferdinand Cortes (1524–25), of Pedro de Alvarado (1524), of Luis Marin (1523 ?), and of Adelantado Francisco de Montejo (1526–27); and shows hypothetical boundaries of the great kingdoms of Mayapan and Quiché, which fortunately for the Spaniards came to an end before their day.

ATTENTION has been drawn by Dr. G. A. Dorsey (*American Anthropologist*, x. p. 169) to the frequency of Wormian bones in the coronal suture in artificially deformed skulls of the Kwakiutl Indians of Vancouver Island. He explains their occurrence by bandaging in early life, and he finds that the percentage of frequency becomes the greater as we ascend the scale of length of the cranium due to artificial elongation, and just in direct proportion to a deep well-defined groove behind the coronal suture. The long bones of the Kwakiutl and Salish Indians of British Columbia have also been studied by Dr. G. A. Dorsey in the same journal. The radio-humeral index is 75·5; the lengthening may be due to intermixture with Indians of the east or south. The tibio-femoral index is 79·1, the intermembral index is 70·7, and the femero-humeral index is 72·8. These indices approach very closely, and indeed often equal, those which have been determined for the Eskimos, the Samoyeds, and the Lapps.

ATTENTION has previously been drawn (NATURE, vol. liv. p. 404) to the good work in Indian anthropology that is being done by Mr. Edgar Thurston, the superintendent of the Madras Government Museum. The second volume of the Museum *Bulletin* opens with an account of the Badagas and Irulas of the Nilgiris, the Paniyans of Malabar and the Kuruba or Kurumba; there are numerous tables of measurements, and seventeen plates. The Paniyans are a dark-skinned tribe short in stature (1574 mm., 5 ft. 2 in.), dolichocephalic (74), with broad noses (min. 83·7, max. 108·6, av. 95·1), and curly hair. The common belief that they are of African origin is erroneous. They are wholly uneducated, and do not associate with other tribes. A short account is given of the customs and manner of living of this primitive Dravidian tribe. The other tribes mentioned by the author also exhibit Dravidian characters to a greater or less extent. In the interesting summary which closes this small but valuable memoir the author draws attention to the rapid modification of the natives through contact with the European, and to the need for immediate ethnographical investigations before it is too late. He says: "I was lately shocked by seeing a Toda boy studying for the third standard in Tamil, instead of tending the buffaloes of his mand. The Todas, whose natural drink is milk, now delight in bottled beer and a mixture of port wine and gin. Tiles and kerosine tins are employed instead of the primitive thatch. A Bengali babu, with close-cropped hair and bare head, clad in patent-leather boots, white socks, dhuti, and conspicuous unstarched shirt of English device; a Hindu or Parsi cricket eleven engaged against a European team; the increasing struggle for small-paid appointments under Government—these are a few examples of changes resulting from the refinement of modern civilisation."

THE first part of a Report by M. Ch. Rabot (International Commission on Glaciers) on the variation in the length of glaciers in the Arctic regions, has been published in the *Arch. Sci. Phys. et Nat., Geneva*. All available evidence is here collected from many scattered sources, and though the evidence is admittedly imperfect, it enables some interesting conclusions to be drawn. There is no sign of a general retreat corresponding to that of the Alpine glaciers after 1850. In Greenland the ice seems to be stationary at a maximum now. In Iceland, the eighteenth century was marked by a general increase, interrupted by a partial decrease, only to be followed by a very extensive advance which has lasted through most of the nineteenth century. A slight retreat began in the north of the island about 1855–60, and twenty years later in the south; but this is not comparable with the marked retreat in the Alps. Grinnel Land and Jan Mayen are also dealt with in this instalment of a valuable report.

THE double number of *Spelunca*, which completes the third volume, maintains the high standard of its predecessors. Among other articles are one on the Kentucky Mammoth Cave, and one on the caves of County Leitrim.

MESSRS. A. GALLENKAMP AND CO., makers of chemical apparatus, wish it to be known that, in the new premises to which they have just removed, they propose to exhibit in their show-room examples of new instruments described in scientific periodicals, and of apparatus kept in stock.

A BIOGRAPHY and an account of the botanical labours of the late Prof. Julius Sachs, by Prof. Goebel, appears in the pages of *Flora*; and one of the late Fritz Müller, by Prof. Ludwig, in the *Botanisches Centralblatt*. Each memoir is accompanied by a copious bibliography.

ANOTHER new botanical journal is announced from America, the first number to appear on October 1. It is to be named *The Plant World*, and will be an illustrated monthly journal of popular botany. "It will," says the *Botanical Gazette*, "present the facts of plant-life in simple popular language, and aim to interest those who have no inclination for a systematic course of study. The purpose is to be scientific, but not technical." The editor will be Dr. J. F. Knowlton, of the U.S. National Museum.

AMONG papers on physiological botany recently received from America are "The Curvature of Roots" by Mr. D. T. McDougal, and "The Rôle of Water in Growth" by Mr. C. B. Davenport. In the former the author points out that the curvatures of stems are not due to the same causes as those of tendrils or of many roots. The curvature of roots is due to the excessive elongation of the internal layers of the cortex of the side which becomes convex. The development and organisation of irritability in roots has been widely different from that in stems. The organs of the irritable mechanism of roots exhibit a physiological rather than a morphological differentiation.

THE additions to the Zoological Society's Gardens during the past week include a Badger (*Meles taxus*) from Worcestershire, presented by Mrs. Cheape; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. B. Hudson; a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. J. W. Drysdale; a Peregrine Falcon (*Falco peregrinus*), British, presented by Major Hawkins Fisher; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Mr. John Paget; a Crowned Lemur (*Lemur coronatus*) from Madagascar, two Korin Gazelles (*Gazella rufifrons*, ♂ ♀) from Senegal; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, deposited; two Common Sandpipers (*Tringoides hypoleucus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

BOND'S COLLECTED WORKS.—It is stated in *Science* that, at the request of the daughters of George Bond, Prof. Holden, Director of the Lick Observatory, has undertaken to arrange the manuscript material in their hands in an orderly form. The work will be entitled "Memorials of William Cranch Bond, Director of the Harvard College Observatory, 1840-59, and of his Son, George Phillips Bond, Director of the Harvard College Observatory, 1859-65," and will be published by Messrs. C. A. Murdock and Co., San Francisco, and by Messrs. Lemcke and Büchner, New York City. The book will be well illustrated. It is hoped, by the kindness of Prof. E. C. Pickering, to reproduce two fine steel engravings of the Great Comet of 1858 and of the nebula of Orion, from the plates of the *Annals* of the Harvard College Observatory.

ECLIPSE EXPEDITION OF THE LICK OBSERVATORY.—We learn from the Publications of the Astronomical Society of the Pacific, that the Lick Observatory expedition to observe the forthcoming solar eclipse will consist of Prof. Campbell and volunteer assistants. The expenses of the expedition will be met from a fund provided by the late Colonel C. F. Crocker. The programme will include spectroscopic and photographic work, and an equipment will be taken to obtain the following results, among others:—Photographs of the spectrum of the reversing layer; spectrum photographs having for their special object the determination of the velocity of rotation of the corona; photographs of the corona on a large scale (40 feet long), on the plan employed by Prof. Schaeberle in Chile; photographs of the corona with a portrait lens; photographic photometry of the corona.

A REMARKABLE BINARY STAR.—Recent observations leave practically no room for doubt that the close double star β 883 = Lalande 9091 (R.A. = 4h. 44m. 33s., Decl. + 10° 52′, Mags. 7·8 and 8), has the shortest period of any known binary. The star was discovered by Mr. Burnham in 1879, and Schiaparelli made a number of measures of it between 1887 and 1895, and upon combining these observations with other measures, Dr. T. J. J. See was forced to the conclusion that the period was only a few years. Further considerations give support to this view, and now Dr. See (*Monthly Notices*, R.A.S., June 1897), from a discussion of the whole of the facts of observation, concludes that the period is only 5·5 years.

The elements of the orbit are given as follows:—

$$P = 5{\cdot}5 \text{ years} \quad \alpha = 0''{\cdot}621$$
$$T = 1896{\cdot}40 \text{ ,,} \quad \Omega = 20^\circ{\cdot}6$$
$$\epsilon = 0{\cdot}760 \text{ ,,} \quad i = 82^\circ{\cdot}52$$
$$\lambda = 273^\circ{\cdot}83$$

Apparent orbit:—

Length of major axis =	0″·67
Length of minor axis =	0″·16
Angle of major axis =	19°·5
Angle of periastron =	318°·0
Distance of star from centre	0″·07

Referring to this remarkable object, Dr. See says:—

"The discovery of an object revolving in a period of 5·5 years is an achievement of some philosophic significance in the history of double-star astronomy. In the time of Sir John Herschel the most rapid of known binaries was ζ Herculis, with a period of 35 years. Twenty years ago the remarkable object 42 Comæ Berenices had reduced the shortest period to about 25 years, and in 1887 δ Equulei brought it down to 11·5 years. κ Pegasi (β 989) has since been shown to revolve in a similar period.

In β 883 we have for the first time a visible binary with a period fairly approaching those of the spectroscopic binaries recently discovered, and we seem assured that at last a link has been found connecting the two classes of objects. It is probable that other stars will disclose even shorter periods, for there is no reason why there should not be close doubles with periods of a single year or less. It will be an interesting object of future research to fill in the intervening steps between visible binaries with periods of a few years and the spectroscopic binaries revolving in a few days or months.

"The more critical inquiry into the motion of close doubles will commend itself to the attention of double-star observers with great telescopes, and, on the other hand, it may be hoped that the study of the relative motion in line of sight of the components of binaries like β 883 will be taken up by some of our great observatories equipped with powerful spectroscopic appliances."

FORTHCOMING BOOKS OF SCIENCE.

MR. EDWARD ARNOLD'S list contains:—"Higher Algebra," by Dr. R. Lachlan; "The Elements of Trigonometry," by Dr. R. Lachlan; "Analytical Geometry," by Dr. R. Lachlan; "The Elements of Euclid," Books III., IV. and VI., by Dr. R. Lachlan; "Dynamics for Engineering Students," by Prof. W. E. Dalby; "Elementary Natural Philosophy," by Alfred Earl; "An Elementary Chemistry," by W. A. Shenstone; "Physical Chemistry," by Dr. Alexander Scott; "Practical Chemistry," by Dr. E. H. Cook; "A Manual of Physiology," by Dr. Leonard Hill; "A Manual of Botany," by David Houston; Arnold's Practical Science Manuals: "Steam Boilers," by George Halliday; "Agricultural Chemistry," by T. S. Dymond; "Electric Traction," by Ernest Wilson; "Lectures on Sound, Light, and Heat," by Dr. Richard Wormell, new edition.

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In Messrs. William Blackwood and Sons' list we find:—"A Sketch of the Natural History (Vertebrates) of the British Islands, with a bibliography of over two hundred works relating to the British Fauna, and a List of Field Clubs and Natural History Societies at present existing in the United Kingdom," by F. G. Aflalo, illustrated; "Wild Traits in Tame Animals: being some familiar Studies in Evolution," by Dr. Louis Robinson, illustrated; "A Manual of Agricultural Botany," from the German of Dr. A. B. Frank, translated by Dr. John W. Paterson, illustrated; "Things of Everyday: a Popular Science Reader on some Common Things," illustrated; "Introductory Text-Book of Meteorology," by Dr. Alexander Buchan, new edition, illustrated; "Dr. Mackay's Elements of Physiography," rewritten and enlarged, illustrated; "Page's Introductory Text-Book of Geology," new edition, revised and enlarged by Prof. Lapworth, F.R.S.; "Page's Advanced Text-Book of Geology, Descriptive and Industrial," with engravings and glossary of scientific terms, new edition, revised and enlarged by Prof. Lapworth, F.R.S.; "Introductory Text-Book of Zoology, for the Use of Junior Students," by Prof. Henry Alleyne Nicholson, F.R.S., new edition, revised and enlarged, illustrated.

The Cambridge University Press announces:—"The Collected Mathematical Papers of the late Arthur Cayley, F.R.S." (to be be completed in thirteen volumes), vols. xii. and xiii.; "The Scientific Papers of John Couch Adams, F.R.S.," vol. ii., edited by Prof. W. G. Adams, F.R.S., and R. A. Sampson; "The Theory of Groups of a Finite Order," by Prof. W. Burnside, F.R.S.; "A Treatise on Universal Algebra, with some applications," by A. N. Whitehead. Vol. i. contains the general principles of algebraic symbolism, the algebra of symbolic logic, the calculus of extension (*i.e.* the algebra of Graffmann's Ausdehnungslehre), with applications to projective geometry, to non-Euclidean geometry, and to mathematical physics; "A Treatise on Octonians: a development of Clifford's Bi-Quaternions," by Prof. Alexander McAulay; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A Treatise on Geometrical Optics," by R. A. Herman; "An Elementary Course of Infinitesimal Calculus, for the use of Students of Physics and Engineering," by Prof. Horace Lamb, F.R.S.; "Theoretical Mechanics: an introductory Treatise on the Principles of Dynamics, with numerous applications and examples," by A. E. H. Love, F.R.S.; "The Works of Archimedes," edited in modern notation, with introductory chapters, by Dr. T. L. Heath; "The Steam Engine and other Heat Engines," by Prof. J. A. Ewing, F.R.S.; "Collected Mathematical Papers," by Prof. P. G. Tait; "Crystallography," by Prof. W. J. Lewis; "Geology," by J. E. Marr, F.R.S.; Cambridge Natural Science Manuals, Biological Series—"Fossil Plants: a Manual for Students of Botany and Geology," by A. C. Seward, in two volumes; "Vertebrate Palæontology," by A. S. Woodward; "Handbook to the Geology of Cambridgeshire," by F. R. Cowper Reed; Physical Series—"Electricity and Magnetism," by R. T. Glazebrook, F.R.S.; "Sound," by J. W. Capstick.

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Noumenon in ihrem Verhältniss zu einander bei Kant. Ein Beitrag zur Auslegung und Kritik der Transcendental-philosophie," by Dr. George Dawes Hicks; "Der tägliche Wärmeumsatz im Boden und die Wärmestrahlung zwischen Himmel und Erde," by Theodor Homén; "Ein Beitrag zu einer sicheren Behandlung von Rachen-Diphtherie und Scharlach ohne Serum," by Dr. F. Lueddeckens; "Die wissenschaftlichen Grundlagen der analytischen Chemie, Elementar dargestellt," by Prof. W. Ostwald, Zweite vermehrte Auflage; "Pflanzenphysiologie, Ein Handbuch des Stoffwechsels und Kraftwechsels in der Pflanze," by Prof. W. Pfeffer, Zweite ganz umgearbeitete Auflage, Erster Band: Stoffwechsel; "Darwin und nach Darwin, Eine Darstellung der Darwinschen Theorie und Erörterung Darwinscher Streitfragen," by Dr. George John Romanes, F.R.S., iii. Band: Darwinsche Streitfragen, Isolation und Physiologische Auslese. Mit Bewilligung des Herausgebers aus dem Englischen übersetzt von Dr. B. Nöldeke, Mit d. Bildniss v. Rev. J. Gulick; "Zur Psychologie des Erkennens, Eine biologische Studie," by Dr. Gustav Wolff.

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LONG RANGE TEMPERATURE AND PRESSURE VARIABLES IN PHYSICS.[1]

METHODS OF PYROMETRY.

THE endeavour to provide suitable apparatus for high temperature measurement is one of long standing. The student of the subject is fairly overwhelmed with the variety of devices which have been proposed. There are few phenomena in physics which have not in some way or other been impressed into pyrometric service, often indeed by methods of exquisite physical torture. I cannot, of course, even advert to many of these this afternoon, as my purpose will have to be restricted to such devices as have usefully survived. Thus a whole group of "intrinsic thermoscopes," as Lord Kelvin calls them—apparatus in which some property of the substance is singled out for measurement—will be overlooked. Pyrometry will some day receive substantial aid from the phenomena of solid thermal expansion, dear to the hearts of old Wedgwood, of Prof. Daniells, of the citoyen Guyton-Morveau, and recently to Prof. Nichols, Dr. Joly and others; but even the "meldometer," which has received Ramsay's encouragement, and recent heroic attempts to measure the expansion of platinum, have not yet entered the arena to stay.[2] The same may be said of vapour pressure, ebullition and certain dissociations, of which the former is entirely too liberal in dispensing pressure, and the latter too negligent in readjusting it. Little has been done with heat conduction regarded as subservient to the measurement of high temperatures; little with colour and the spectrum, even though Draper and Langley in America, and many others elsewhere have paid tribute; little with polarisation. The wave-length of sound has told Cagniard Latour and our own A. M. Mayer much about high temperature, but it did not tell them enough.

Throughout the history of pyrometry, *fusion* seems to have come forward for journeyman duty. What is more convenient than to find whether the degree of red heat is too low or too high from the fusion of prepared alloys. As far back as 1828 Prinsep, aware of the golden opportunity, with his air thermometer determined the melting point of some equally sprecious alloys of

[1] An address delivered by Prof. Carl Barus, before the Section of Physics, at the Detroit Meeting of the American Association for the Advancement of Science, August 1897.

[2] Noteworthy attempts to replace mercury by a liquid potassio-sodium alloy in glass thermometers are among the novelties.

gold, silver and platinum, and determined them very well. Other alloys were afterwards substituted, and graded mixtures made of quartz, chalk, kaolin and felspar for the purpose. Efforts to obtain more accurate values are due to Becquerel, but the absolute values most widely used until quite recently, namely, the melting points of silver (958°), gold (1035°), copper (1054°), palladium (1500°), platinum (1775°), iridium (1950°), are due to the researches of Violle.

Interest in high-temperature fusions has of recent date rather increased than abated. The demand for more accurate data has been met by the Reichsanstalt, and we have now a set of values for silver, copper, gold, nickel, palladium and platinum in terms of the air-thermometer standard of that institution. Data have also been supplied by Callendar. Among these values there is as yet considerable confusion, and the end is not yet. Long ago I suspected that the Violle melting points were probably too low, whereas the assumed zinc boiling point is probably too high. This surmise has been partially borne out by the Reichsanstalt, though Le Chatelier even now prefers Violle's values.[1]

Thermoscopes based on a *specific heat* have an advantage over fusion thermoscopes in not being discontinuous. They are quite as "intrinsic" and much less convenient in practice. Guyton-Morveau at the beginning of the century pointed out the pyrometer importance of specific heat, and a host of observers followed him. But the critical discussion of the subject is due to Pouillet (1836), who determined the thermal capacity of platinum between 0° and 1200° absolutely, and found a value so nearly constant as to place this method of pyrometry in a very favourable light. Other observers followed with new data, and the bulk of our knowledge to-day is again due to Violle. Violle used Deville and Troost's exhaustion air thermometer, and determined the law of variations of specific heat and temperature throughout a large pyrometric interval with a number of metals, silver, gold, copper, palladium, platinum, iridium among them. It was by prolonging this law as far as fusion that the melting points of the metals, to which I have already alluded, were obtained. This verges on extrapolation, but it is not extrapolation gone mad.

The importance of calometric high temperature measurement has recently been accentuated in connection with the remarkable high temperature accomplishments of Moissan. Furnace temperatures in the case of such technological operations as are used in connection with iron, glass and porcelain manufacture, rarely exceed 1400°; except perhaps in the Bessemer process, where the temperatures are wont to exceed 1600° and even reach 2000°. In Moissan's furnace, which is essentially an electric arc enclosed by non-conducting lime, a totally new order of high temperatures is impressed. There was thus a call for at least an approximate measurement of their values which was answered by Violle, assuming that the specific heat of carbon above 1000° approaches a limit of 0·5 calorie. The sufficiency of this hypothesis is not unchallenged, however; for instance, Le Chatelier finds that, up to 1000°, the specific heat of carbon continually increases having no certain limit. Admitting Violle's results, Moissan's furnace temperatures exceed 2000° even at 30 amperes and 55 volts; at 360 amperes and 70 volts tin and zinc oxides melt and boil; they exceed 3000° at 500 amperes and 70 volts, where lime melts, and often boils. Moissan, however, went as far as 1000 amperes at 50 volts.

The striking novelty of Moissan's work is rather of chemical interest, and a large part of it is so fresh in our memory that in view of Moissan's valuable book ("Le Four électrique," par Henri Moissan; Paris, Steinheil), I need merely glance at it. A range of fusibilities, among which platinum lies lowest, while chromium, molybdenum, uranium, tungsten, vanadium, follow in order, and of ebullitions beginning with silica and zinc oxide, is rather breath-taking. Finally his structural investigations on the occurrence of carbon, and his long series of carbides, many of them commercially valuable, have staggered even the sensational press.

Leaving other intrinsic thermoscopes for the moment, I will ask your attention in this place to the development of the only fruitful method of absolute pyrometry which has yet been devised.

[1] The following table contains a brief summary:

	(Violle)	(Barus)	(Callendar)	(H. & W.)
Ag.	954°	986°–985°	982°	971
Au.	1045	1091–1093	1037	1072
Cu.	1054	1096–1097		1082
Ni.	—	1476–1517		1484
Pd.	1500	1585–1643		1587
Pt.	1775	1757–1855		1780

I refer, of course, to the gas thermometer, or, in other words, to the manometric methods of measuring the thermal expansion of gases. Efforts have indeed been made to use gaseous viscosity for absolute high temperature work. It has been definitely pointed out, inasmuch as viscosity in gases is independent of pressure, while both viscosity and volume increase with temperature, that the transpiration rates of gases through capillary tubes of platinum glazed externally would necessarily be an exceedingly sensitive criterion of the variation of high temperatures. The small volume of the transpiration pyrometer as compared with the clumsy fragile bulb and appurtenances of the air thermometer is further to the point. But modern kinetics has as yet failed to fathom the law of variation of viscosity with temperature, and even the researches of O. E. Meyer in this direction do not seem to have quite touched bottom. Gaseous transpiration pyrometry is thus still much in the air, surveying the horizon of a glorious future.

Returning from this digression to the air thermometer, we find the first thorough-going piece of high temperature work carried out by Prinsep (1829) by the aid of a reservoir of pure gold, to which I have already alluded. Prinsep's manometer was filled with olive oil, and the volume issuing at constant pressures was found by the balance. In view of the pure olive oil, probably available in 1829, these experiments must have been comfortably appetising, and I dare say Prinsep's good humour in the matter may have contributed to the remarkable excellence of his results. Prinsep's researches were not superseded until Pouillet, in 1836, published his paper on pyrometry. Pouillet constructed an air-thermometer bulb of platinum, and was thus able to reach the farthest pyrometric north of the day and long after. His results are many-sided; they contain the first definite data in radiation pyrometry and in calometric pyrometry. His constant pressure manometer, afterwards further perfected by Regnault, is the best apparatus for the purpose to-day. Pouillet did not suspect, indeed he remained quite unaware of, the permeability of platinum to furnace gases; perhaps for this and other reasons he failed to detect the thermo-electric anomalies in the platinum-iron couple which he has so carefully calibrated.

It was thus a great step in advance when Deville and Troost long after replaced platinum by glazed porcelain, availing themselves (1857–60) of Dumas' famous vapour density method for measuring temperature. Unfortunately for the rapid progress of pyrometry Deville and Troost used iodine vapour in their bulbs, a heavy gas indeed, but a gas, as was afterwards found, whose low temperature molecule dissociates at higher temperatures. Thus they unwittingly committed an even greater error than Pouillet in gliding over permeable platinum; and their data for the boiling points of zinc and of cadmium were about 100° too high. In fact these results were challenged not long after by Becquerel (1863), who had fallen heir to Pouillet's platinum air thermometer, had used it to calibrate a platinum-palladium thermo-couple of his own, and had found data for the boiling points of zinc and cadmium upwards of 110° below those of Deville and Troost. I cannot here enter upon the discussion which thereafter arose between these active observers, further than to state that in the course of it both parties frequently repeated their measurements (Becquerel even substituting a porcelain bulb for Pouillet's thermometer) without removing the discrepancy between their values.

Later researches have decided in favour of Becquerel's results, and his original research, with its applications to fusion, to radiation, to thermo-electrics, &c., is one of the noteworthy accomplishments in the history of pyrometry. Nevertheless it must not be forgotten that to the investigation of Deville and Troost our knowledge of the perviousness of iron, platinum, and other metals to gases is due. We are also indebted to Deville for the great discovery of dissociation, the very phenomenon which he was here so loth to acknowledge. This is the case of a man stumbling in his own footprints. Victor Meyer was, I believe, the first to point out the probable dissociability of the iodine molecule, suggesting a fruitful subject of research which has since been extended to many other molecules.

In 1863, Deville and Troost began a new series of high temperature researches, the feature of which is the perfected form of porcelain bulb. This was a hollow sphere and long capillary stem adapted for use with Regnault's standard air thermometer. Great difficulties were encountered in the endeavour to glaze the bulbs within. They were finally overcome by making bulb and stem separately, and then soldering them together with felspar before the oxyhydrogen blow-pipe. Elaborate measurements

on the thermal expansion of Bayeux porcelain accompanied these researches which, undertaken together with M. Gosse of the Bayeux works, occupied them intermittently for about seven years. A full summary of their data did not appear, however, until 1880, when, together with a new vacuum method of high temperature air thermometry, they communicated the results of twenty-seven measurements on the boiling point of zinc. Their new results are in good accord with the data of Becquerel, already cited, and the more recent results of Violle and others for the same landmark in the region of high temperatures. Measurements between 0° and 1500° had thus reached a degree of precision of about 15° in 1000°.

The further development of pyrometry took a somewhat different direction. Regnault (1861) had already made use of a displacement method, in which the measuring gas is removed bodily into the measuring apparatus by an absorbable gas. But the method was independently revived by Prof. Crafts, of the Boston Institute of Technology. These methods are not of especial excellence below 1500°; but above that temperature, when most solids tend to become viscous, their importance increases (as Crafts duly pointed out) in proportion to the rapidity with which the measuring operations can be completed. One or two minutes may suffice, and different gases may be tested consecutively. It is in this way that Victor Meyer and his pupils, after demonstrating the dissociation of iodine and chlorine molecules, succeeded in penetrating quantitatively to very much less accessible heights of temperature. A particular desideratum was a rigid test as to the stability of the molecule of the standard measuring gases (oxygen, hydrogen, nitrogen). The results were favourable inasmuch as for these and for many gases, like CO_2, SO_2, HCl, Hg, &c., the expansions obtained were linear functions of each other.

In their final work, temperatures as high as 1700° were reached, the air thermometer for this purpose being tubular in form, consisting of very refractory fire-clay with an interior and exterior lining of platinum and with two end tubulures of platinum for influx and efflux of gases. Among many results of great chemical interest their researches showed that metallic vapours, phosphorus, sulphur, &c., at high temperatures tend to pass into the monatomic or the diatomic molecular structure.

Some time after (1887) a series of experiments furthering the line of research of Deville and Troost were made with a geologic aim in view in the laboratory of the U.S. Geological Survey. Finally, porcelain air thermometry was taken up with great vigour by the Reichsanstalt. These results, due to Holborn and Wien, are now almost exclusively quoted, and carry the stamp of the great institution from which they emanated. They have been wisely made commerically available by the deposition with Heraus in Hanau (Germany) of a platinum rhodium alloy definitely calibrated for a temperature range of 1400°.

Apart from this, these researches contain no essential novelty except, perhaps, a more detailed attempt to investigate the stem error of the thermometer bulb; their procedure otherwise is identical with the method developed in America. I am not therefore inclined to yield to it the unhesitating deference which has become customary. There can be no doubt, in view of the splendid facilities due to the co-operation of the Royal Prussian Porcelain works—facilities which those who have been baffled by porcelain technology, or have had to coax unwilling manufacturers into reluctant compliance, will appreciate—that the data of the Reichsanstalt will eventually be standard. For the present, however, I should be more impressed by some sterling novelty either in the direction of a larger range of measurement, or of method. Conceding that an accuracy of 5° at 1000° has been reached, all results above 1500° remain none the less subject to increasingly hazardous surmise.

A beautiful method of absolute thermometry, albeit as yet only partially developed, is due to Töpler. In this the densities of communicating columns of gas are compared very much as in Dulong and Arago's classical method for liquids, by the gravitation pressures which correspond to these unequally hot columns. To accomplish such extremely fine-pressure measurement, Töpler invented the "Druck libelle," an inversion, as it were, of the common level, in which therefore the motion of the bubble (or of a thread of liquid) indicates a change of pressure conditioned by the invariable horizontality of the instrument.

The development of the practical forms of continuous intrinsic thermoscopes (the *radiation*, the *thermo-electric*, and the electric *resistance* methods) went more or less hand in hand with the development of the air thermometer, although the latter is decidedly the more recent. Aside from pioneering experiments of Müller (1858) and others, the well-known Siemens resistance pyrometer (1871) was the first instrument in the field. It was based upon data obtained from platinum, copper and iron, by the calometric method of calibration. This instrument has been remarkably perfected by Callendar and Griffiths, using specially pure platinum calibrated by comparison with the air thermometer as far as about 600°. Notwithstanding these improvements the resistance pyrometer is inferior in my judgment to the thermo-electric pyrometer on account of the greater bulk and fragility of the exposed parts, and the tendency of platinum to waste itself gradually at high temperatures. Its upper limit of temperature measurement is thus limited; for even if the difficulty of selecting suitable terminals for the coil is set aside, the difficulty of finding an insulator at very high temperatures would remain. According to Holborn and Wien resistance is seriously subject to the influence of furnace gases, and permanence of the low temperature constants does not imply a like permanence of the high temperature constants of the metal.

Radiation pyrometry, curiously enough, is the most venerable method within the whole scope of the subject. It was introduced by Newton (1701) in his *scala graduum caloris*, in connection with his well-known law of cooling. Not to mention minor workers, it was successively attacked and revived in most of the noteworthy high temperature investigations. Pouillet and Draper have studied it; Becquerel, Crova, Violle, Le Chatelier, Langley, Nichols, Paschen and others have advanced it. It remains to-day the most promising, as well as puzzlingly fascinating, subject for pyrometric research. One need merely advert to its broad scope in relation to the temperature of the heavenly bodies to acknowledge this. Here I can only allude to Becquerel's principle that the radiation of opaque bodies is spectrometrically alike at the same temperature, a result which has Crova's more recent assent; to Violle's photometric measurements of the total emission of platinum; to the more recent work in the same direction of Violle and Le Chatelier, in which consistent results were obtained for oxide of iron and platinum as far as 1500° to 1700°; to Stefan's law, as proved by Boltzmann and the variety of discussion it has elicited; to H. F. Weber's collateral equation; to the Johns Hopkins measurements, &c. Another school of observers, including Langley, Paschen, and others, has undertaken the promising but much more laborious method of bolometric measurement of the distribution of spectrum energy in its relation to temperature. Without doubt, however, the whole subject is yet *in primis rudimentis*; the results are confessedly "intrinsic." Indeed, vagueness in the nature of the radiating source lowers with sufficiently threatening aspect to chill the fondest hopes. When one is told by Violle, working on Mont Blanc, that the temperature of the sun is 2500°; thereupon by Rossetti that it is 9965°, by Le Chatelier that it is at least 7600°, by Paschen that it is below 5000°, by Wilson and Gray that it is 8000°, &c., one wisely concludes that more may yet be learned about it. Our sympathies naturally go with those who, like Lummer and Wien and the Johns Hopkins people, are beginning fundamentally with the search for an absolutely black body. Less superstructure and more sub-cellar is perhaps the watchword in radiation pyrometry.

Turning now to the last and most important of the methods of practical pyrometry, we find a curiously meandering evolution apparent. I have already indicated that Pouillet (1836) was the first to complete a legitimate piece of calibration work. Pouillet might have condemned the method, but for some reason Tait's thermo-electric anomalies of red-hot iron were not detected. Regnault (1847), who was the next to take up the subject as it happened with the same couple, made this condemnation sweeping enough. It was not the real perversity of the platinum-iron couple which provoked Regnault, for of this neither he nor Pouillet became aware. Regnault's objection (as we should put it to-day) lay in the fact that the thermo-couple obeyed Ohm's law, which in that early day lay somewhat beyond the great physicist's range of interest. Fortunately, but none the less long after, Becquerel followed with his palladium and divers platinum couples, carefully calibrated and efficiently used. What these platinum couples were is not stated. They cannot have been very sensitive, or they would have been preferred to the palladium-platinum couple. Indeed, the metallurgy of platinum alloys did not reach a degree of refinement until Deville and Debray (1875) overhauled the chemical separation of platinum

metals with particular reference both to iridium and to rhodium. Recently Mylius and Förster at the Reichsanstalt further contributed to platinum metallurgy. But in view of the toils in which the whole subject of high temperature measurement languished in Becquerel's day, his results were not sufficient to remove the discredit which Regnault had thrown upon thermo-electric pyrometry. And so it happened that the return to the method in recent date was of the nature of a resuscitation.

It is amusing to note, as we pass on, the pranks of custom as it bore down upon pyrometry. Following Deville and Troost, every worker (I might mention at least five) felt in duty bound to redetermine the boiling point of zinc—rather a difficult feat in its way. Thus we find boiling zinc inseparably associated with the destiny of the calibrated thermo-couple. Le Chatelier broke this law of fateful sequence by ignoring the need of calibration at the outset, and then using the couple so dignified to determine the melting points of silver, gold, palladium and platinum. But these are Violle's melting points. Hence the pyrometric feature of Le Chatelier's platinum-rhodium couple was in its inception due to Violle.

Meanwhile, accompanying the geologic inquiries of Clarence King, an extensive series of pyrometric investigations which had been in progress in the United States since 1882 were completed (1887). These contained a full examination of divers efficient methods of pyrometry and a study of the porcelain air-thermometer with particular reference to the calibration of thermo-couples. In the course of this work the admirable pyrometric qualities of the platinum-iridium alloy were exhibited by detailed and direct comparisons with the air thermometer. It was shown that the calibration could be made permanent by referring the thermo-electromotive forces to a Clark's cell; that the character of their variation with temperature is uniformly regular, and that the thermal sensitiveness of the couples increases as the higher degrees of red and white heat are approached. Finally it was pointed out that couples destroyed by silicate corrosion, or in similar ways, could be restored by fusing over again on the lime hearth with merely negligible changes of constants. Elsewhere, Le Chatelier's clever combination of the platinum-rhodium couple with the D'Arsonval galvanometer, then a comparatively new instrument in the laboratory, secured immediate favour. Prof. Roberts-Austen, ever on the watch to waft good things across the channel from Gaul into Albion, hailed the new-comer with no uncertain sound. Some time after, the platinum-rhodium couple entered Germany, and was there definitely calibrated (1892) for the first time, as already stated, at the Reichsanstalt.

Of the three available couples, palladium, platinum-rhodium and platinum-iridium, the former is excluded from competition by reason of its low fusibility. Between platinum-iridium and platinum-rhodium, the latter has been more extensively advertised but is otherwise inferior to the older platinum-iridium alloy. In other words, platinum-iridium, when suitably alloyed, can be made more sensitive than platinum-rhodium in the ratio 100 to 76. Beyond this the alloys are much alike; both are tenacious, resilient, refractory metals, and their thermo-electric forces under like conditions of temperature show a constant ratio even at extreme white heats. The thermo-electric activity of these two alloys is exceedingly remarkable. Among over fifty different platinum alloys examined no similarly sensitive combinations were found. Moreover, whereas platinum alloys of extremely large electrical resistance are not unusual, such metals are not to be distinguished thermo-electrically.

To conclude: the small dimensions of the sensitive point of the thermo-couple, the independence of the intermediate temperatures between the junctions (apart from small corrections due to the Thomson effect), and therefore the removal of the terminal difficulty, the high upper limit of the measurable temperatures, the permanence of its constants in relation to Clark's cell in the lapse of time, the instantaneity of its indications, the easy reproduction of destroyed couples, their relative insensitiveness to furnace gases, the regular and simple character of the temperature function, the sustained sensitiveness throughout all temperature ranges even quite into the fusion of platinum—all these facts are a sufficient if not an overwhelming recommendation of the method.

In speaking of long range temperature variables, one is hardly permitted to overlook the remarkable work which has recently been done in the direction of low temperature; but with these subjects I am less familiar, and can therefore only refer to in passing. The progress made in the subject is sufficiently evidenced by the growth of large low temperature laboratories throughout the world, laboratories which undertake "the cold storage" of "cold storage," as it were, like those of Pictet in Berlin and Paris, of Dewar in London, of Kamerlingh Onnes in Leyden, of Olszewski in Krakau, and others. Dewar and Fleming have added to our knowledge of the probable constitution of bodies at the absolute temperature. Olszewski has found the critical temperature of hydrogen at $-230°$ and its atmospheric boiling point at $-243°$. Dewar and Moissan have liquefied fluorine. There is much here which I must reluctantly forego. The hydrogen thermometer, the platinum balance (Callendar), and the thermo-couple are again doing excellent work in thermometry.

APPLICATIONS OF PYROMETRY.

Turning now to the applications of recent pyrometry, we meet first many series of valuable data on melting points and similarly valuable data on the dissociation temperatures of chemical compounds. To these I merely refer, not being qualified to enter into chemical interpretations. High temperature boiling points have also been treated, and I will especially consider the case of the variation of metallic ebullition with pressure. The relation of vapour pressure to temperature has thus far defied the counsels of the wise, even though such men as Bertrand and Dupré have given the matter close scrutiny. One would suspect the simplest relation to hold for metallic boiling points, and investigations have therefore been undertaken in which the temperature of ebullition of Hg, Cd, Zn, Bi, were studied for pressures decreasing from one atmosphere down indefinitely.

The results so obtained show an effect of pressure regularly more marked as the normal boiling point is higher, so that the attempt to express the phenomenon for all these bodies by a common equation is roughly successful. By far the most rapid reduction of boiling point occurs when the pressure decreases from $\frac{1}{10}$ atmosphere indefinitely. For the case in which the normal boiling point is to be predicted from a low pressure value in case of a metal which, like bismuth, boils with great difficulty, very high exhaustion is essential.

Igneous fusion, by which I mean the fusion of rock-forming magmas, is particularly interesting in its relation to pressure. This has been again recently pointed out by Clarence King in his discussion of the age of the earth. If the earth is solid within, as is now generally admitted, such solidity can only result from superincumbent pressure withholding fusion. To study the relation of melting point to pressure directly is out of the question when white heat is the condition of fusion. In this respect the laboratory in the interior of the sun or even of the planets has some salient advantages; but we cannot comfortably put such a laboratory under strict surveillance of protoplasm.

Fortunately the Clapeyron equation, successively improved by James Thomson and by Clausius, is here usefully available. To measure the melting point, the difference of specific volumes of the solid and the liquid body and the latent heat of fusion at this temperature, with the aid of Joule's equivalent, is to measure also the relation of melting point to pressure implicitly. Based on the first and second laws of thermodynamics, this equation is generally true, no matter what specific properties may characterise the body. The process has thus far been completely pushed through for diabase only. Thermal change of volume may be measured by enclosing the rock in a platinum tube of known expansion, and the contraction of the contents from liquid to solid found by an electric micrometer probe reaching within the tube. Given a furnace fully under control, then, as experiment has shown, the cooling can be made to take place so slowly that platinum remains rigid relatively to its charge of red-hot magma, and under these conditions the contraction can actually be followed into the solid state. At the same time, the temperature at which marked change of volume occurs is the melting point. Apart from difficulties of manipulation, the latent heat may be found from measurement of thermal capacity on either side of the temperature of fusion, by a modification of known methods.

The rate at which fusion is retarded by pressure, computed from these data in the manner specified, showed an increase of the melting-point of a silicate of about 0·025° C. per superincumbent atmosphere. But this datum falls within the margin (0·02 . . . 0·04) of corresponding data much more easily and directly derived for organic bodies. One may therefore argue that if the melting-point pressure rate is so nearly constant on passing from the class of siliceous to the thoroughly different and

much more compressible class of organic bodies, the rate would probably be more nearly constant in the same body (siliceous or organic) changed only as to temperature and pressure. This surmise was verified for naphthalene within an interval of 2000 atmospheres.

The endeavour to interpret the change during fusion of the volume of the chemical elements in terms of the periodic system has been begun with much success by Max Töpler for low temperatures. It would be of great interest to complete this diagram for high temperatures in view of the specifically molecular character of the fusion phenomenon, by repeating such experiments as have just been described for rock magmas.

The heat conduction of rocks has been investigated in many cases for temperatures lying below red heat. Among recent observers we need only instance the extensive investigations of Ayrton and Perry. No trustworthy experiments, however, have yet been carried into the region of essentially high temperature; and yet, what is chiefly of interest in the geological applications of such experiments is the change of conduction which accompanies changes of physical state, whether induced by pressure or by temperature.

Experiments in heat conduction are difficult under any circumstances. They become insuperably so when conduction at white heat is to be studied under pressure, and that is what the geological conditions actually imply. Some notion of a body respectively solid and liquid at a given temperature may be obtained by observing the behaviour of bodies which are capable of being under-cooled. A number of such bodies are known, thymol being a conspicuous example. Experiments with this body were made by measuring the volume expansion, specific heat, and heat conduction in parallel series both for the solid and liquid state at like temperatures. They showed, for instance, that the increment of absolute heat conduction, encountered in passing isothermally from the solid to the liquid state, when referred to solid conductivity is about 13 per cent., and when referred to a liquid conductivity is about 15 per cent. Similarly, the change of thermometric conductivity, under like conditions, is an increment of 36 per cent. and 56 per cent. respectively. Now, since in most questions relating to thermal flow thermometric conduction enters exclusively, the importance of this large coefficient is obvious whenever a body passes from the solid to the liquid state.

Solid conduction is thus 40 or 50 per cent. in excess of liquid conductivity for the same body at the same temperature and pressure. It is reasonable to infer that a corresponding decrement of conduction will accompany any rise of temperature of a solid body. Measurements which have somewhat recently been made for relatively small intervals at Zürich, at Glasgow, and at Harvard upon typical rocks, all bear out this surmise. The immediate incentive to these experiments was a strong paper by Prof. Perry, in which Lord Kelvin's estimate of the age of the earth is shown to be insufficient for an earth in which the interior conductivity is systematically greater than the surface conductivity. Indeed, he deduces the percentage increment of the square root of the age of a Perry earth over that of a Kelvin earth to be one-fifth of the percentage decrement of conduction for each 100° C. So far as the effect of terrestrial temperature alone is concerned, the measurements just mentioned show that Perry's correction is negative or that Perry's earth would be less long-lived than the 100×10^6 limit of years set by Lord Kelvin.[1]

To estimate the effect on heat conduction of the increase of pressure which accompanies the increase of temperature with the depth below the surface is a much more serious matter. In the laboratory, pressure experiments are limited to 3000 or 4000 atmospheres; compared with earth pressures, these scarcely amount to a scratch on the surface; yet even for this limit the determination of heat conduction at high temperatures is out of the question. A tentative method of arriving at a conclusion is given by Clarence King in his discussion of the age of the earth, the consequences of which have been quite overlooked. What King endeavoured to accentuate, long before Perry's contribution to the subject, was precisely the fact we *cannot* assume greater conductivity for the interior than for the surface. Since heat conduction decreases isothermally from solid to liquid, it was assumed that, in one and the same substance, the viscosity could be taken as an index of the thermal conduction. Therefore if temperature and pressure were made to vary in such a way (both increasing) as to leave viscosity constant, it was inferred that heat conduction would also remain constant. Now the isometrics or lines of constant viscosity of a viscous body for variable pressure and temperature are much more easily found than the isometrics of conduction. In fact, it has been shown that a burden of at least 200 atmospheres would have to be brought to bear in order to wipe out the decreased viscosity due to the rise of a single degree (Centigrade) of temperature. The depth at which this ratio is reached, as King points out, for a given surface gradient of temperature and depth, depends on the initial excess of the temperature of the earth considered, and on the age of the temperature distribution resulting. But no matter whether the Kelvin earth with an initial excess of 3900 and an age of 100×10^6 years, or whether King's solid earth with an initial temperature of fused platinum and 25×10^6 years of life, be taken—in all cases the temperature effect predominates throughout those depths within which change of temperature with depth is the marked feature of the temperature distribution. In other words, if, for example, we consider the Kelvin earth, the strata above 0·035 of earth radius will be strata of smaller conduction than the surface strata. From the surface downwards as far as 0·035 radius, conduction will decrease to a minimum. Below this, conduction will increase again due to preponderating pressure, finally to exceed the surface value. But the computed temperature distribution of Kelvin's earth is such that at ·035 radius the initial temperature excess of 3900° has been reached to within 1 or 2 per cent. Below this in depth, Perry's correction would begin to apply, but the further changes of temperature are so nearly negligible that the consideration of conduction is superfluous. From this point of view, therefore, the staggering force of Perry's clever argument is removed. Of course, I am fully aware that an argument from the supposed parallelism of physical properties of a given body (in the present case heat conduction and viscosity) is not inevitably convincing; but in physical geology, for some time to come I dare say, the question will be not one of rigorous proof, but rather one of forming a rational opinion.

In passing I will indicate the importance of an increased knowledge of the isometrics of liquid and solid matter, relations which have thus far been found simpler in character than other thermodynamic properties, as I shall again point out in the course of the address.

I want, finally, to add a few words on the electro-chemistry of magmas. The physical chemistry of molten rock has already been somewhat extensively considered, but I am hardly competent to review it. In the United States, Joseph Iddings and, more recently, George F. Becker have discussed the natural differentiation of magmas from different points of view. Here I will merely include certain pyrometric experiments on the electric conduction of fused glasses which seem to give promise of throwing light on the chemical constitution of complex silicates and to be suggestive in other ways. In such measurements, if the magma is made to pass from the solid to the liquid state, the observed electric conduction contains no evidence either of a melting point or of polymerism. The law of thermal variation is easily derived and it agrees closely with the corresponding behaviour of a zinc sulphate solution, for instance, observed through a range of temperature. In a general way, electric resistance decreases in geometric progression when temperature increases in arithmetical progression. Considered relatively to the composition of the magmas, electric conduction shows a marked and regular increase with the degree of acidity of the magmas. The less fusible acid magmas are better conductors than the basic magmas at the same temperature. Curiously enough, conduction thus runs in an opposite direction to fusibility. However viscous a magma may be, therefore, and however cogent the arguments such as those launched by Becker against the differentiating importance of ordinary diffusion may prove, it is fair to conclude that a thorough change of chemical structure through *ionic* diffusion, whether directed by an electric field or otherwise, must be an easy possibility for a sufficiently hot, but otherwise solid, magma. The results point specifically to the desirability of repeating Hittorf's brilliant experiments on the migration of the ions for a siliceous medium. This ought not to be difficult, seeing that such a menstruum need not even be liquid to be compatible with a high order of electric conduction.

Further consideration of the subject shows the probable passage of conduction through a maximum when acidity is con-

1 The text of Kelvin's recent address at the Victoria Institute, in which an age of thirty million years is maintained, has not yet reached me.

tinually increased. Finally, quartz appears like an insulator in the same *rôle* as water in ordinary aqueous solutions. In all these cases I wish to keep in mind the results of Alexeëff and their recent repetition for metallic alloys, together with the interpretation of these results due to Masson. In a crust subject to variable magnetism, traversed by earth currents, sustained by semi-metallic carbides of the Mendeleëff-Moisson type, containing piezo-electric and thermo-electric sources, who can say that electric fields are absent? Again, the character of the changes contemplated in Gibbs's famous "phase rule," as interpreted by Le Chatelier, would here be ionic rather than molecular.

A question of somewhat allied interest is the action of hot water under pressure on rock-forming silicates. Investigations of this kind have been described in the well-known and fascinating book of Daubrée. Daubrée's work, however, is qualitative in character, like that of many others in the same line, and the furtherance of the subject is to be looked for in the quantitative direction. Some time ago, Becker suggested experiments on a huge mass of granulated rock under the action of steam at exceptionally constant temperature. But no thermal effect of the action of water could be detected. True, the boiling point of water is a temperature relatively low for the purpose; yet similar experiments made with liquid water at over 200° under pressure were equally negative as to results. Experiments of this kind are not very conclusive. The insufficient sensitiveness of the measuring apparatus, the rate at which heat is carried off compared with the rate of generation, and other obscure causes mar the results. The question may, however, be approached in a somewhat different way: if water is heated under pressure in glass tubes, the volume of water contained decreases as the square, whereas the chemically active area, *i.e.* the inside surface of the tube, decreases as the first power of the diameter. Hence, in proportion as the tube is more capillary, the action of water on the glass will produce accentuated volume effects. Thus it was shown that the behaviour of hot water is profoundly modified by its continued action on glass, inasmuch as its compressibility increases at a very rapid rate with the time of action even at 180°, until, with the approach of solidification, the observed compressibility is fully three times its isothermal value at the inception of the experiment. Even more striking is the simultaneous and continual decrease of the length of the column of water. Clearly, therefore, the confined volumes of glass and included water must undergo contraction at 180° in forming an eventually solid aqueous silicate, while increasing compressibility is due to the increasing quantity of silicate dissolved. Now, in nearly all cases the effect of solution is a decrease of compressibility. Hence the increased compressibility observed is to be referred to a precipitation of the dissolved silicate, in response to the action of pressure, a result borne out by the appearance of the tube and by varied correlative experiments. It is, however, the volume contraction which is particularly interesting, because of its far-reaching geological application. In the first place, the measurements show that about ·025 cubic cm. of liquid water is absorbed per square centimetre of glass surface at 180° C. per hour.[1] The effect of this absorption is a contraction of bulk amounting to 18 per cent. per hour. So large and rapid a contraction is presumably accompanied by the evolution of heat. Hence, under conditions given within the first five miles of the earth's crust, *i.e.* if water at a temperature above 200° and under sufficient pressure to keep it liquid be so circumstanced that the heat produced cannot easily escape, the arrangement in question is virtually a furnace whose efficiency accelerates with rise of temperature or increase of terrestrial depth.

PIEZOMETRY.

It is not feasible to make much progress in pyrometry without feeling the need of a corresponding development in high pressure measurement. This has already appeared in the preceding parts of my address. It will not be expedient to look into the history of the subject so comprehensively as I did in the case of pyrometry, partly because the literature is more diffuse, and partly because the real development of piezometry is of recent date and virtually begins with pressures of the order of several thousand atmospheres. So understood, although we gladly pay homage to Oersted, to Regnault, to Grassi and many others, our historical summary may be abridged.

As is often the case in physics, the great advances in the subject are associated with the name of one man; for though many able investigators have contributed effectively to the progress of piezometry, the overshadowing importance of the results of Amagat have superseded all researches coextensive with his own. For over twenty years Amagat has been labouring on this definitely circumscribed subject. Year after year his prolific experimental ingenuity has put forth results, each of which in its turn constituted the highest attainment in accuracy and the greatest breadth of scope which high-pressure measurement had reached at the time. It is impossible to give any adequate view of this sustained labour in an address. The subject is highly specialised and demands special treatment; but we owe to Amagat the bulk of our knowledge of the properties of a gas regarded not as an ideal fluid, but as a physical body; some of the most far-reaching results in the thermodynamics of liquids and some of the best data in the elastics of solids.

Amagat investigated gases within an interval of pressure which at times reached 4000 atmospheres, with a view to interpreting their divergence from the laws of ideal gaseity. Indeed we may note in passing that, just as the advanced astronomy of the day is being enriched with unexpected discoveries from a discussion of mere errors of observation, so refined physical measurement gleans new harvests in carefully tracing out the all but rigorous sufficiency of established laws. The product of pressure and volume, nearly constant in the ordinary isothermal behaviour of gas, shows, under higher pressures, a well-marked passage through a minimum in the case of all gases except hydrogen. Hence below a certain definite pressure, varying with the character of the body (say 40 atm.), gases are more compressible than Boyle's law asserts, and above this pressure they are continually less compressible and begin to resemble hydrogen in this respect. The sharpness of the minimum diminishes as temperature increases and probably ultimately vanishes. Cailletet, it is true, had undertaken a study of the same subject simultaneously, but his results were not in the same degree correct. Again, the coefficient of expansion of gases considered in its isopiestic behaviour for temperatures not too far above the critical point, increases with pressure to a maximum, which seems to occur at the same pressure for which the volume-pressure product is a minimum. This thermal maximum also decreases with temperature and finally vanishes. To specify the conditions further than this would be to exceed the limits beyond which verbal statement ceases to be lucid. The value of Amagat's work, however, is not merely the formulation of such general laws for gases as a whole, but rather the investigation of sharp and specific results for each gas individually. Thus if one uses these data for a given gas to compute the constants in Van der Waal's law, one is actually able to predict remote critical conditions of the gas in question with a fair degree of accuracy.

Whenever pressure measurements are to be made through such large intervals as are here in question, the elastic constants of the apparatus become of increasing moment. Amagat, however, treated these incidental measurements as of like importance with the rest of his labours. The starting point of his investigation into high pressures was the open mercury manometer first erected along a staircase near Lyons, finally in the shaft of the St. Etienne Mine, about 380 metres deep. This apparatus was used for graduating the closed manometer, preferably containing nitrogen. In later experiments for excessively high pressures, the closed manometer was replaced by the "manomètre à pistons libres," a sort of inverted Bramah press, in which the small pressures of an open mercury manometer acting on a large piston compensate the relatively large pressures of the piezometer acting on a small piston. The ingenious feature of Amagat's apparatus is the rotation of both pistons just before measurement, a device by which friction is rendered harmless. Equipped with this instrument, direct determination of the bulk modulus for glass and metals was actually feasible. In the case of glass no serious variation of the compressibility could be ascertained within 2000 atmospheres and even 200°, an observation of great value in practical research. Poisson's ratio was similarly determined, and the data used in computing Young's modulus. But the most important result of these researches, a result to which Prof. Tait also contributed, is the datum found for the absolute compressibility of mercury. This will enable all future observers in piezometry to standardise their apparatus with ease and nicety.

Time prevents me from dwelling upon the remaining investi-

[1] This is an initial rate of about 180 kilograms per square metre per year.

gations of Amagat in a measure commensurate with their value. These contain a counterpart for the liquid state of the results already announced for gases. The change of volume throughout enormous pressures and about 200° of temperature is considered in detail for a number of important liquids. Only in one case, and that the rather remarkable one of carbon tetrachloride, are evidences of solidification encountered, and the conditions determined. Amagat believes the absence of solidification to be due to the occurrence of the lower critical temperature below the isothermal of compression. In my own judgment, however, the pressures necessary to reach this lower critical point will be enormous even in units of 1000 atmospheres, for which reason it is not in any case liable to be an easy conquest.

Special mention, finally, is due to the thermal position of the maximum density of water, which Tait had already studied. Amagat shows definitely that the temperature of maximum density moves towards the freezing point with increasing pressure, so that at high pressures, as well as at high temperatures, the behaviour of water loses its anomalous character. In general, compressibility and expansion decrease with pressure for all normal liquids, and expansion increases rapidly with temperature. Other anomalous properties of water have been investigated, among which the diminished viscosity of water under pressure at ordinary temperature, studied by Röntgen, Cohen and others, may be stated.

After this cursory and wholly inadequate mention of the work of Amagat and the physicists who, like Tait, Cailletet and others, have been engaged in closely allied researches, it will repay us to look at some of the other as yet less splendidly developed contributions to piezometry. At the outset it is well to make mention of the forms of pressure gauges which have come into use. As far as 1000 atmospheres, the Bourdon gauge, if well constructed, does good service, though in a somewhat rough way. The corrected nitrogen closed manometer is more accurate for a smaller range. A theoretically simpler pressure gauge was proposed by Tait and Cailletet. In this case a straight cylindrical elastic tube under internal or external pressure is substituted for the Bourdon tube, and the expansion or compression is directly measured. With due precautions against changes of temperature and the choice of a solid of constant bulk modulus and rigidity, this gauge can be used as far as about 2000 atmospheres with convenience.

Above 2000 atmospheres, Amagat's Bramah press manometer, already mentioned, is the only trustworthy gauge, and though somewhat cumbersome has the advantage of giving absolute results. However, a gauge based on the change of electric resistance of mercury with pressure, a constant now fairly well known from Palmer's measurements, will in my judgment do good service for pressures which exceed even the range of the manometer. With regard to methods for producing high pressures, the force pump, with a small steel plunger and the screw advancing bodily into a closed barrel filled with a liquid, have not yet been superseded. The efficiency of such apparatus depends essentially on the means used for obviating leakage. These must, of course, be very perfect.

Amagat's work with liquids was extended chiefly in the direction of high pressures. Experiments have since been made by others throughout higher temperatures (310°), and of course a smaller range of pressures (500 atm.). Leaving out the less perspicuous results, I will here merely allude to the probable existence of a remarkable law which these researches have developed. Dupré (1869) and afterwards Lévy (1878), reasoning from thermodynamic premises, were the first to suspect that the isometrics or lines of equal volume of liquids are straight. In other words, if there is to be no change of volume, then pressure increments must vary proportionately to the temperature increments ($p = a\theta - b$), a result which implies that the internal pressure of a body kept at constant volume is proportional to its temperature. Lévy's deduction was, however, declared to be theoretically unwarrantable by Clausius, Boltzmann and others. Some time after, the same law reappeared in experimental form in a series of brilliant researches on critical temperatures due to Ramsay and Young. Fitzgerald, reasoning from Ramsay and Young's results, then proved that for such liquids as possessed straight isometrics, specific heat is a temperature function only, and energy and entropy are each expressible as the sum of a mere temperature function and a mere volume function. This is curiously like the position from which Dupré and Lévy started. Ramsay and Young's work, however, applied specifically to vapours, and for high temperatures (200°) their pressures did not exceed 60 atmospheres. The law has since been tested for liquids as far as 1500 atmospheres and over 200° conjointly, and found in reasonable accordance with experiment. Hence we infer that if the thermodynamic change of a body is such that volume remains constant, pressure and temperature will vary linearly with each other, the increments being about 0·1° C. per atmosphere. Now, although any law relating to the liquid state would be welcome, these volume isometrics are particularly so. In the geology of the earth's crust, for instance, they would in a great measure determine the conditions of possible convection; and it is curious to note that from the known values of bulk modulus and of the expansion of solid glass, the isometrics would here again be given by corresponding increments of about 0·1° per atmosphere. For solid metals the isometrics are of a different order.

Another line of research for liquids to which I attach supreme importance has only just been begun: I refer to the systematic study of the *entropy* of liquids. Among the first results on the heat produced in suddenly compressing a liquid are those of Tait. They are of too limited a range, however, and not in good accord with the more recent and extended data of Galopin. Generally speaking, the change of temperature produced per atmosphere of compression increases with temperature in a marked degree, as one may infer from Kelvin's equation. For organic bodies this increment at ordinary temperatures is of the order of $\frac{1}{50}^\circ = \cdot 020^\circ$ per atmosphere. In case of liquid metals the order of values is decidedly different, being about $\frac{1}{10}$ this value, recalling correspondingly divergent results observed for the isometrics of volume. Quite recently (1896) the same subject has been taken up by Tammann (to whom we also owe results for the correlative compressibilty), particularly for solutions and with reference to the theory of solutions. Tammann's data are of the order 0·001° per atmosphere at 0°, and in better keeping with the thermodynamics of the subject than the earlier experiments. Much more, however, must be done before anything like a degree of critical accuracy is approached or a broad survey taken. Pressure intervals are to be chosen wider, and the temperature measurement given with greater certainty.

Finally, I wish to touch upon the relations of melting-point and pressure in their more recent development. Obviously the classical work of Andrews on the continuous passage of a liquid into the gaseous state will find some counterpart in the manner in which the analogous passage from the solid into the liquid state takes place. The character of these phenomena may be shown from direct observations of melting-point and pressure, as was done by the earlier observers. Full knowledge, however, can be obtained only by mapping out the isothermals throughout the region of fusion very similarly to the method pursued by Andrews himself for vaporisation. This has thus far been attempted for a single body only, naphthalene, within 130° and 2000 atmospheres. Six isotherms (63°, 83°, 90°, 100°, 117°, 130°) were traced within these intervals, along each of which, excepting the first, the body passed from the liquid to the solid state under the influence of pressure only. An exhibit of these data shows strikingly that in all cases the change of physical state takes place in accordance with a cyclic law; *i.e.* a larger pressure is necessary to change the body from the liquid to the solid state at a given temperature, than the pressure at which the body at the same temperature again spontaneously melts. Freezing almost always seems to take place at once; the corresponding fusion is apt to be prolonged, and in its gradual occurrence traces the contours of James Thomson's well-known doubly-inflected isothermals much more fully than does the allied case of vaporisation.

The appearance of the cyclic parts of these isothermals is suggestive, and may be described in terms of their dimensions in the direction of volume and of pressure respectively. The former dimensions indicate the probable fate of the volume increment. They show that as pressure and temperature increase, the volume increment tends more and more fully to vanish, and they thus imply a lower critical temperature at which the solid would change into the liquid continuously as far as volume is concerned. It does not follow that other properties of the body would here also vary continuously. For naphthalene this point would lie in a region of several thousand atmospheres, and several hundred degrees Centigrade—therefore in a region too remote to admit of actual approach.

Again, the breadth of the cycles, measured along the pressure

axis, decreases from the centre of the field both in the direction of increasing and decreasing pressures. The tenour of these results is an additional indication of the recurrence of a lower critical temperature at which cycles must necessarily vanish. The decrease of the breadth of the cycles in the direction of decreasing pressures suggests the possible occurrence of a point in the region of negative external pressure, so circumstanced that beyond it the substance would solidify at a lower pressure than that at which it fuses. This may be interpreted as follows: the normal type of fusion changes continuously into the ice-type of fusion through a transitional type characterised by the absence of volume lag.

An independent discussion, more searching in character, has quite recently been given by Tammann. Tammann points out that for the normal case of fusion and for increasing pressure, the two determinative factors of the Clapeyron equation—the volumes and latent heat of fusion—will not in general simultaneously become and remain zero. He argues that the volume constant will at the outset decrease with pressure passing through zero to negative values. Hence the curve representing the relation of melting-point to pressure must initially rise to a maximum when the melting-point pressure ratio is zero, and then decrease. Contemporaneously the latent heat of fusion, decreasing continually with pressure, eventually also reaches zero, but at a much later stage than the volume constant. At this stage, therefore, since melting-point and the volume constant now have definite values (the latter negative), the melting-point and pressure ratio is negatively infinite. Hence the curve expressing the relation of melting-point to pressure decreases with increasing pressure from the maximum specified as far as the pressure at which latent heat is zero, and there drops vertically downwards. Thus Tammann's melting-point pressure curve, with its initial and final ordinate in the direction of temperature, maps out a field of pressure and temperature, within which the body is solid. Outside of this region the body is liquid, and cannot by pressure alone be conceivably converted into the solid state. Any thermodynamic change involving a march through the boundary of this region is accompanied by the discontinuity of fusion, of viscosity, &c. A march through the final ordinate (for which latent heat is zero) is probably not accompanied by such discontinuity. For a given temperature there may be two fusion pressures. At a temperature sufficiently below the melting-point, the continued increase of pressure should therefore move the normally fusing body from the solid into the liquid state continuously. This is a somewhat anomalous result of close reasoning; but it must not be forgotten that in the depth of our ignorance of the actual occurrences above several thousand atmospheres, the term anomaly is a misnomer. Indeed, if we regard the melting-pressure curve beyond the stated maximum as characterising the ice-type of fusion (which Tammann does not do), our difficulties would in a measure be reconciled.

Tammann finally points out that the term lower critical temperature is not justified by the character of the phenomenon. Data for melting-point and pressure, due to Damien, seem directly to corroborate the occurrence of zero values in the ratio of melting-point and pressure increments, but Damien's tests are restricted to a pressure interval much too small to be trustworthy. Of the two bodies which have been tested throughout long-pressure intervals, naphthalene shows a linear melting-point and pressure ratio for 2000 atmospheres, while the carbon tetrachloride of Amagat, though initially concave upwards, soon also becomes linear. Clarence King has therefore, in geological considerations, so represented it. To conform with Tammann's inferences the interior of the earth would have to be a fluid.

One point of issue, however, in these cases is clear: at Andrews' critical temperature both the difference of specific volumes and the latent heat of fusion vanish simultaneously wherever observed. Under corresponding conditions of change from liquid to solid, the internal pressures are of tremendously greater value for both states, and the passage of the solid into the liquid molecule may involve an immense transfer of energy without any corresponding change of volume: for the density of the molecule itself eludes observation. The manner of this isothermal change from one state to the next is in all cases along the characteristic doubly inflected contour first pointed out by Thomson for vapours, and since elaborated by Van der Waals, Clausius and others. We may for brevity call this a *volume lag*, and measure it in terms of the pressure or the volume interval subtended. The liquid can exist even above the critical temperature, which would mean that even here pressure must be reduced below the critical pressure in order to rupture the liquid molecule.

Pronounced as these phenomena are for the change from gas to liquid, they become much more remarkable, indeed often formidable, for the change from liquid to solid. In this case a volume lag subtending more than 100 atmospheres is the rule; in other words, it takes a much greater pressure to solidify a liquid at a given temperature than to liquefy the solid. Among all these cases there is a group of well-known bodies in which, while the solidification pressure is of marked intensity, the isothermal pressure of spontaneous fusion may even be below zero, or be in the region of negative pressure. Take the single example of thymol, among many: this body between zero Centigrade and its melting point at 53°, can be kept in either the solid or the liquid state at pleasure. Given at about 50° in the liquid state it would require more than 2000 atmospheres to solidify it. If solid, it must obviously remain so even if pressure be wholly removed. But thymol may be similarly treated, beginning with the under-cooled liquid state at 28°, *i.e.* 25° below its melting point. Even here at least one thousand atmospheres are needed to condense it (400 have been tried quite ineffectually). Once solid, it would require about 1000 atmospheres of *negative* external pressure again to melt it. In other words, it could not be melted again on the same isothermal.

If we but knew more about the physical constants involved in these transformations, we could predict the results along the lines of J. W. Gibbs's splendid theory of the equilibrium of heterogeneous mixtures; but with the dearth of our concrete knowledge of long range physical phenomena relating to liquids and solids, we must be content with humbler methods.

I have always regarded the significant behaviour, instanced for the case of thymol, as capable of a broad interpretation. Profs. J. J. Thomson and Fitzgerald in the British Isles, and Elihu Thomson in America, have recently sought for atomic dissociation in the electrolysed vacuum of a Crookes' tube. Speaking to the same point, I would venture to assert that we may reasonably look to the volume lag for a rational account of the genesis of atoms. We have already met with two orders of volume lag: the first at the mergence of gas into liquid being usually a few atmospheres in isothermal value; the second at the mergence of liquids into solid, a hundred or even one thousand times as large in isothermal value, and characterised by the fact that, whereas freezing pressures may be enormous, the corresponding isothermal melting pressure may even be markedly negative.

If then we further inquire as to what will happen if we indefinitely compress the solid along a suitable isothermal, I think it is logically presumable that, with the succeeding and profoundly accentuated volume lag, we shall reach the next atom in a scale of increasing atomic weights.

However enormous the condensation pressure for this purpose may be, it is supposable, in the light of the examples already given that, along an accessible isothermal, the disintegrating external pressure of the new atom may be permanently negative. Hence the new atom will persist within the pressure and temperature range available in the laboratory.

But the last stage is virtually identical with the first, or the inherent nature of these changes is periodic. The inference is therefore that, under suitable thermal conditions and continually increasing pressure, the evolution of atoms, of molecules, of changes of physical state, again of atoms and so on indefinitely, are successive stages of periodically recurring volume lag.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Rev. A. M. Fairbairn, Principal of Mansfield College, Oxford, will distribute the prizes to the successful students of St. Thomas's Hospital on Saturday, October 2, at 3 p.m., in the Governors' Hall.

PROF. ROBERT G. AITKEN and Mr. W. H. Wright have been appointed assistant astronomers at the Lick Observatory.

A NEW centre of the London County Council Technical Education Classes will be opened next Monday evening, October 4, at the Charterhouse and Rogers' Memorial Institute, Goswell Road, E.C. The committee of the school announce that workmen's classes in workshop arithmetic, workshop chemistry and physics, workshop drawing and mechanics will be conducted.

THE revised regulations relating to the subjects of examination for degrees in science at the University of London were published a few days ago. The regulations come into force at the beginning of 1899. The subjects for matriculation are Latin, English, mathematics, general elementary science (a new subject), and any one of the following languages or sciences:—Greek; French; German; Sanskrit; Arabic; Elementary Mechanics; Elementary Chemistry; Elementary Sound, Heat, and Light; Elementary Magnetism and Electricity; Elementary Botany. The general elementary science refers to the physical and chemical properties of matter, and the subject will be treated, wherever possible, from an experimental point of view, numerical examples or problems being restricted to very simple calculations. In the intermediate examination in science, candidates will only be required to take up three of the following subjects, viz.: (1) Pure and mixed mathematics; (2) experimental physics; (3) inorganic chemistry; and (4) botany and zoology. It will thus be possible for students of physical science to obtain a pass or take honours without studying the biological subjects; and, on the other hand, biological students will not need to take up mathematics. For the final B.Sc examination, eight subjects are given, and candidates will be examined in any three of them. The subjects are:—Pure mathematics, mixed mathematics, experimental physics, chemistry, botany, zoology, animal physiology, geology, and physical geography. All the syllabuses have been revised, and their general tendency is towards a fuller practical knowledge of the subjects than has hitherto been expected from candidates.

PERHAPS the most critical period in the career of a man of science is when he has completed his college course but has not established himself sufficiently to obtain a post of any value. For the benefit of promising students thus situated, the municipality of Lyons has, it is stated, decided to make some provision. According to the announcement, the municipality proposes to lend to young men on leaving the University the funds necessary "for their first needs," on their simple word of honour to repay the sum advanced as soon as their pecuniary position allows them to do so. The *British Medical Journal*, in referring to this action, says:—A similar humane principle has indeed long been acted upon by the Union des Anciens Étudiants de l'Université Libre of Brussels, which not only provides bursaries for deserving poor students, but in case of need procures employment for them after graduation, and in some cases a loan to start them in a profession. But this is the work of a private body, and the help that can be given is on a much smaller scale than the Lyons municipality proposes to give. The German Government, in certain cases, allows students to go through the University curriculum without payment of fees on their undertaking to discharge the liability when they are able to do so, and the old University of Paris was sometimes equally accommodating. It is often, however, even more difficult to find a market for academic and professional knowledge than to acquire that knowledge, and it is to such cases that the Lyons municipality proposes to lend the needed helping hand. The Fellowships of the older universities of this country have a distinct use for the same purpose, but they are for the few, and not always for those who most need them, nor perhaps for those who would make the best use of them. The Companies of the City of London seem not infrequently to find it difficult to dispose of their unearned increment in a really useful way. We venture to commend to them the example of the City of Lyons. We also congratulate the University of Lyons on its connection with a Corporation so enlightened and so anxious to further its interests.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 20.—M. A. Chatin in the chair.—On the hypocycloid with three inflections, by M. Paul Serret.—On oxycellulose, by M. Léo Vignon. This substance is prepared from cellulose by the action of hydrochloric acid and potassium chlorate, and its composition is expressed by the formula $C_{24}H_{33}.O_{21}$. Its absorptive power for dyes is greater than that of cellulose. Oxycellulose behaves as an aldehyde towards Schiff's reagent.—On retamine, by MM. J. Battandier and Th. Malosse. The combination of this base with hydrobromic, sulphuric, and hydriodic acids have been prepared, the last-named being obtained in fine crystals, $C_{15}H_{26}N_2O.2HI$.—The influence of colouring matters upon the fermentation of highly coloured red wines, by MM. P. Carles and G. Nivière. The incomplete transformation of sugar into alcohol in highly coloured wines is not due to the acidity, but to the antiseptic action of the colouring matter itself.—On the function of *Pseudocommis vitis* (Debray) in two diseases of the vine, by M. E. Roze.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Quantitative Chemical Analysis: Profs. Clowes and Coleman, 4th edition (Churchill).—City and Guilds of London Institute, Programme of Technological Examinations, Session 1897–98 (Whittaker).—Traité Élémentaire de Mécanique Chimique fondée sur la Thermodynamique: Prof. P. Duhem, Tome 2 (Paris, Hermann).—Glimpses into Plant Life: Mrs. Brightwen (Unwin).—Organic Chemistry for the Laboratory: Prof. W. A. Noyes (Easton, Pa., Chemical Publishing Company).—University College, Bristol, Calendar for the Session 1897–98 (Bristol, Arrowsmith).—Thermo-Geographical Studies: C. L. Madsen (Williams and Norgate).—International Congress on Technical Education. Report of the Proceedings of the Fourteenth Meeting, held in London June 1897 (Trounce).—An Introduction to Geology: Prof. W. B. Scott (Macmillan).—In Northern Spain: Dr. H. Gadow (Black).—Epping Forest: E. N. Buxton, 4th edition (Stanford).—Vorles-ungen über Bakterien: Dr. A. Fischer (Jena, Fischer).—Among British Birds: O. A. J. Lee, Part 6 (Edinburgh, Douglas).—Diagrams illustrating Principles of Mining: F. T. Howard and F. W. Small (Chapman).—Elementary Practical Physiography (Section 1): J. Thornton (Longmans).—First Principles of Electricity and Magnetism: C. H. W. Biggs (Biggs).—University Geological Survey of Kansas, Vol. 2 (Topeka).—British Central Africa: Sir H. H. Johnston (Methuen).—Elementary Geometrical Statics: W. J. Dobbs (Macmillan).—The Story of Germ Life: H. W. Conn (Newnes).—The Mathematical Psychology of Gratry and Boole: M. E. Boole (Sonnenschein).—Deductive Physics: F. J. Rogers (Ithaca, N.Y., Andrus).—Wild Neighbours: Outdoor Studies in the United States: E. Ingersoll (Macmillan).—Lectures on Physiology. 1st Series. On Animal Electricity: Dr. D. J. Waller (Longmans).—Les Choses Naturelles dans Homère: Dr. A. Kums (Anvers, Buschmann).—University College of North Wales, Calendar, 1897–98 (Manchester, J. E. Cornish).

PAMPHLETS.—Glacial Observations in the Umanak District, Greenland: Prof. G. H. Barton (Boston).—Theory of the Motion of the Moon: Dr. E. W. Brown (Royal Astronomical Society).—A Descriptive Catalogue of Useful Fibre Plants of the World: C. R. Dodge (Washington).—South American Trade of Baltimore: Dr. F. R. Rutter (Baltimore).—Some New Orchids from Sikkim: G. King and R. Pantling, Pp. 1 and 2 (Calcutta).—Materials for a Flora of the Malayan Peninsula: Dr. G. King, Nos. 8 and 9 (Calcutta).—Flax-growing: Major Fraser (Cable Company).—Les Forces de la Nature, &c.: T. L. Bienkowski, (Lèopol).—Kritik der Exakten Forschung, F. Ego (Leiden, Brill).—Reisen in den Mollukken, &c.: Prof. R. Martin, 1ste Liefg. (Leiden, Brill).—Mineral Statistics of the United Kingdom for the Year 1896 (Eyre and Spottiswoode).

SERIALS.—Psychological Review, September (Macmillan).—Journal of the Franklin Institute, September (Philadelphia).—Archives of the Roentgen Ray, July (Rebman).—American Journal of Science, September (New Haven).—Botanische Jahrbucher, Vierundzwanzigster Band, 2 Heft (Leipzig).—Physical Review, May–July (Macmillan).—Himmel und Erde, September (Berlin).—An Account of the Crustacea of Norway: G. O. Sars, Vol. 2, Parts 7 and 8 (Bergen).—L'Anthropologie, July and August (Paris).—Botanische Jahrbücher, Dreiundzwanzigster Band, v. Heft (Leipzig).—Proceedings of the Physical Society of London, September (Taylor).—Economic Journal, September (Macmillan).—Timehri, June (Stanford).—Zoologist, September (West).—Beiträge zur Psychologie und Philosophie, i. Band, 2 Heft (Leipzig).—Annalen der K.K. Universitäts-Sternwarte in Wien, x., xi. and xii. Band (Wien).—American Naturalist, September (Philadelphia).—Longman's Magazine, October (Longmans).—Sunday Magazine, October (Isbister).—Good Words, October (Isbister).—Annales de l'Observatoire Magnétique et Météorologique de l'Université Impériale à Odessa, 1896 (Odessa).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 41, Part 4 (Manchester).—East Asia, No. 2 (Longton, Hughes).

CONTENTS.

THURSDAY, OCTOBER 7, 1897.

PRACTICAL ELECTRICITY.

Practical Electricity: a Laboratory and Lecture Course for First Year Students of Electrical Engineering, based on the International Definitions of the Electrical Units. Completely rewritten by W. E. Ayrton, F.R.S. Vol. i. *Current, Pressure, Resistance, Energy, Power, and Cells.* Pp. xviii + 643, with 247 illustrations. (London: Cassell and Co., Ltd., 1896.)

THAT the progress of electricity during the last decade has been great appears in many ways; but none shows this progress more strikingly than a comparison of a new and up-to-date book on practical electricity with the work as it originally appeared ten years ago. Prof. Ayrton's book was well-known to all laboratory students of electricity; it contained in moderate compass a vast amount of detailed information of great value, and it had marched well with the times. But the decision of the author to recast his matter, and to issue the book in an entirely rewritten and rearranged form, was none the less a wise one. He has now freer scope to put things in their newer relations and lights, to introduce new matter, and to emphasise those points and topics which still further increased experience and the trend of applications show ought to be more insisted on, and ought to bulk more largely in a thoroughly modern treatment of the subject.

So far only one volume of the new book has been published, and that deals with current, pressure, resistance, energy, power, and cells. The treatment of these topics, it is needless to say, is fresh and vigorous throughout. The individuality of the author is evident in every page, and however we may differ in opinion from him on such subjects as order of discussion, choice of starting points, and the like, there can be no question that for every position taken up, and every deviation from the ordinary routine of an elementary treatise on electricity, the author is provided with a reason which commands attention and respect.

In the brief review which we here propose to make of this volume, we shall first note some points that have struck us in a general survey of its contents, and then allude more particularly to some matters of detail. First, there is the very large number of clearly drawn and well-chosen cuts with which its pages are illustrated. There are 247 in all, about one to every two pages and a half, and about three out of every four of them have been drawn for the present work. This feature of the book is refreshing as contrasted with what one finds in so many text-books, which seem to be to a large extent written up (?) to a somewhat well-worn set of "process" cuts.

Some of the pictures of instruments are beautiful examples of what such illustrations should be. If a shaded diagram is given, it should be clear, and not, as it often is, a more or less smudged kind of impressionist representation of the instrument. Then, essential parts hidden away behind coils or in tubes should in some way be disclosed, and not left to be imagined from a verbal description. Thus, in the drawings of current-meters, in various parts of the book, the device of showing the coils cut open to display the construction, and to reveal suspensions and suspended coils and needles, is adopted with great effect. Some of the cuts of lines of force, which have evidently been engraved from photographs of the actual arrangements, strike us as the finest we have seen; notably one (Fig. 34) of the lines of force in a plane through the axis produced by a circular coil carrying a current, and two (Figs. 57, 57 *a*) of the lines of force of a horse-shoe magnet with curved iron pole-pieces. These last are exceedingly instructive as regards concentration of field and remanent leakage of lines outside the space.

The printing and get-up of the book are all that can be desired. Printed on thin and at the same time opaque paper, it contains 600 pages of text within a bulk not larger than that often given to a book of little more than half the same amount of matter. A clear and well-arranged index has been provided by Miss Ayrton.

Now as to the particular points in the author's treatment, regarding which we would say a word. The book is professedly based on the international definitions of the various units. Hence the discussion of currents begins with the enumeration of the various physical actions of a current, and a decision is come to, the convenience of which is shown in various ways, to regard an unvarying current as proportional to the chemical decomposition it produces in a given time. The unit of current is *defined* as that which passed through a solution of nitrate of silver in water deposits silver at the rate of ·001118 of a gramme per second. Then is given in a very lucid manner much valuable information regarding electrolysis and the quantitative results that have been arrived at in the investigation of the electrolysis of silver and copper, and the electrolytic standardisation of current-measuring instruments.

Now, although the units referred to above have been the subject of international agreement, their adoption is a matter of practical and commercial convenience, and should not be allowed to supersede or put out of sight the direct derivation of the units of current E.M.F., &c., in the absolute C.G.S. system of units. An Order in Council is not a law of the Medes and Persians which cannot be changed; on the contrary, it will have to be altered in any respect in which, under the conditions of future practice, it is found to be too much at variance with later and more accurate determinations of electrical constants, in order to bring it into agreement with the absolute system. The derivation of the absolute unit of current from the magnetic action of a current has a great practical as well as theoretical importance, and constitutes, as it seems to us, the only proper *definition* of unit current. Of course, this definition necessitates, in the first place, a discussion of magnetic effects of currents; but this cannot be avoided, and is, of course, very adequately given later in Prof. Ayrton's treatise. But we prefer that it should come before the electrolytic discussion, as without a familiarity with the specification of the measure of a current by its magnetic action the full force of the results of electrolytic research cannot be quite appreciated. But this procedure adopted, the results of such research connecting currents measured by their magnetic action with their electrolytic effects comes in what seems to us both their natural and their historical place, and the choice of ·001118 gramme of

silver, as the quantity deposited by the passage of the quantity of electricity which is to be taken as unity, loses the air of arbitrariness it must at first sight have to many readers of Prof. Ayrton's book.

The order more usually followed in this matter is also, quite as much as the other, in the spirit of the plan of giving in a treatise on electricity initial prominence to the electric current and its effects. We may remark, though not with reference to anything stated by Prof. Ayrton, that in a good deal of the talk about beginning at this point or that in an exposition of electrical matters, it seems to be forgotten that some previous discussion of elementary magnetic, or it may even be electric phenomena, is desirable and even necessary. To quite understand the action of a current on a magnet, it is necessary to know something about magnets and magnetic fields. The truth is that, in a system logically consistent, as the science of electricity to a very great extent is, the point of attack is very much a matter of convenience. It is possible, of course, and it is done in some recent discussions, to begin with Maxwell's or Hertz's equations for electromagnetic action, and work round to electrostatic action as a mere residual effect. Still, in all such exercitations, a great amount of previous knowledge is taken for granted. The teacher has a difficult task in any case, for he soon finds in whatever way the discussion is undertaken, that to know one thing with approximate completeness it is necessary to know everything else. The study is a process of gradual approximation to clear and accurate conceptions, and if this were more recognised, there would be less discouragement of some students, and on the part of others, less cocksureness and contempt of what does not excite their interest, or is only capable of discussion by methods which have the misfortune to meet with their disapprobation.

A very important section of the book before us is that which deals with the power developed in the circuit of a generator, the conditions for the evolution of the maximum power in the working part of the circuit, electrical and commercial efficiency, and the transmission of power. The thorough practical study of all these questions which Prof. Ayrton has made invests this part of the book with a special interest and authority. Nothing could be clearer and better illustrated by graphical exhibition of the results, and by practical examples, than this long chapter. Perhaps a somewhat more explicit warning might have been added with regard to the fallacy which people apparently *will* fall into of confusing the arrangement of maximum power with that of maximum efficiency. Of course the discussion of efficiency ought to be sufficient to guard against error; but we have not seen the last yet of what at one time seemed inveterate, the continual misapplication of the so-called law of Jacobi.

Of the chapter on cells, &c., we will only say that it is in moderate compass a veritable store of information, which would only be found with difficulty, if at all, after much searching of other books, and to ordinary students more or less inaccessible papers.

By completing the book Prof. Ayrton will confer a further great benefit on all students of electricity, technical or otherwise; and we hope the second volume will not be long delayed. A. GRAY.

PRIMITIVE FRENCHMEN.

Formation de la Nation Française. By Gabriel de Mortillet. With 153 engravings and maps in the text. (Paris: F. Alcan, 1897.)

THE account which Prof. de Mortillet gives of the formation of the French nation is based upon archæological data. It is true that he depends on anthropological materials, but these are prehistoric, and therefore archæological. The anthropological investigations on modern Frenchmen by Broca, Topinard, and others have been neglected; even the brilliant researches of Collignon are not referred to. The book thereby loses somewhat in breadth, and the linkage of the past with the present, which the author so firmly appreciates, would have been brought home more forcibly to the general reader if these investigations had been summarised.

The author first shows that the Bible, legends, ancient texts, and even linguistics, are too untrustworthy to determine the origin of any people; reliance must then be placed on anthropology and palethnology, including archæology. The three terms, race, language, and nationality, are discussed clearly and tersely. Race is an anthropological fact and implies common descent, the prolonged action of environment or complete fusion of various primitive elements. Numerous examples, illustrated by maps, are given to show that the distribution of race and language are by no means identical. If Germany claims Alsace because the population speaks German, why does she retain French-speaking Lorraine? Nationality is a sentiment, and is not based on racial but on sociological reasons. The first half of the book deals with historical documents. The ethnic and geographical discrepancies of various classical authors are pointed out; few had any personal acquaintance with the people and places they described, and most of them romanced. Practically all agree in describing the Celts or Gauls and the Germans in the same terms. Tall, fair people, with blue eyes, white skin, very warlike, and readily undertaking great invasions and vast migrations, constructing neither temples nor towns, fighting naked, but very proud of their hair. But below this military aristocracy there were the common people, ignored by the writers, who constituted the patient and laborious democracy fixed to the soil, the true natives of the country, whom anthropology and palethnology have revealed. The Gallo-Germanic race is spread over nearly the whole of Europe, and extends into Africa and Asia, each band transporting its particular name to the different countries that it occupied.

The languages of France are next dealt with. The remarkable agglutinative Basque language is briefly dismissed, as are also the "Celtic" dialects. "The language spoken in Gaul before the Roman conquest is unknown by us." Various early inscriptions and prehistoric carved stones are briefly reviewed; the latter are classified under (1) simple decorative motives; (2) conventional and commemorative carvings; (3) symbolic carvings, very difficult to understand, but apparently not alphabetical. No reference is made to the remarkable painted stones from Mas-d'Azil.

The third section of the book is devoted to palethnology. Tertiary man is discussed. Mortillet admits

the occurrence of intentionally worked flints in Tertiary beds, but denies that they were made by man for the theoretical reason that the Quaternary beds are characterised by the appearance of man, and if worked flints occur in undoubted Tertiary strata they cannot have been made by man, but by a precursor of man. He acknowledges *Pithecanthropus erectus* to be such a precursor. The Chellian, Acheulian, Mousterian, Solutrian and Madelenian divisions of the Palæolithic period are described and the typical implements figured. Part of the population of France at the close of the Palæolithic period migrated northwards with the reindeer, and he regards the ancestors of the Eskimo as the most ancient French colonists.

The remaining aborigines were swamped by the first invasion of France, men from Western Asia who brought with them the Neolithic civilisation, the art of polishing stone implements and of making pottery; these brachycephalic immigrants domesticated animals, practised agriculture, cared for their dead, and had religious ideas. A second Oriental invasion left a very slight physical influence on the population; it merely reinforced the Neolithic brachycephals, but by the introduction of bronze it effected a tremendous industrial revolution.

The discovery of iron came from Africa, but its introduction into Europe was not marked by any racial movement. Mortillet thus epitomises the three imported stages of culture:—

"The polished stone and the civilisation that accompanied it were brought to us by a violent invasion. Bronze by a slow religious infiltration. Iron arrived simply by commerce and industry."

The anthropological documents are lastly put forward as evidence. The author gives a lucid account of the osteology of the prehistoric races. The race of Neanderthal he would erect into a distinct species. The Upper Palæolithic period is characterised by the race of Laugerie; the most important remains of this race were found in Madelenian deposit at Laugerie-Basse and at Chancelade (both in Dordogne). Mortillet argues that this race was a development *in situ* from the older race, and not a foreign invading type. At the commencement of the Neolithic period a third dolichocephalic race is recognisable; this is often called the race of Cro-Magnon, but as this is not very typical, it is better to term it the race of Baumes-Chaudes, the remains of the cave of l'Homme Mort being less pure than the former. The Baumes-Chaudes and the Cro-Magnon were slightly divergent descendants of the older Laugerie race. Mortillet associates the Cro-Magnon sepulture with the similar triple sepulture at Barma-Grande, and suggests that these were the forerunners of the tall fair Gallo-Germanic invaders.

The mass of the French population consists of the dolichocephalic autocthones who have persisted since Palæolithic times, though they have gradually become modified; the Baumes-Chaudes race of this stock amalgamated in Neolithic times with invading brachycephalic peoples. It is this mixture which has formed the mass of the French people, that sedentary population which may be described as the nucleus of the French democracy. Since then there has always been a turbulent, noisy, mobile aristocracy which alone has filled the pages of history.

Prof. de Mortillet has produced a charmingly written and very lucid account of the conclusions at which he has arrived after a life-long study of all the available materials, and though some of his views may be criticised, all his colleagues will congratulate him on the publication of so useful and instructive a work. A. C. H.

OUR BOOK SHELF.

The University Geological Survey of Kansas. Vol. II. By Erasmus Haworth and assistants. Pp. x + 318. (Topeka: The Kansas State Printing Company, 1897.)

WHEN the full and complete geological survey of a State is undertaken by members of a University faculty, it behoves us to be thankful that the University is so alive to its responsibilities as to work in this way for the "increase and dissemination of knowledge among men." Shortly after the Kansas University opened a graduate department in geology and palæontology, the geological survey of the State was undertaken, and the second volume of results is before us. The work is carried out by members of the University faculty, their advanced students, and other individuals. Like the quality of mercy it is twice blessed, for the State gains by the increase of knowledge of its geology, and the information obtained goes to strengthen the geological departments of the University.

The present volume has been prepared principally by the department of physical geology; and it deals chiefly with the stratigraphic properties of the Cretaceous and younger formations of Western Kansas, little attention being given to economic geology. The papers in the volume are as follows:—"Physiography of Western Kansas" and "The Physical Properties of the Tertiary," by Prof. Erasmus Haworth; "The Upper Permian and Lower Cretaceous," by Prof. Charles S. Prosser; "The Upper Cretaceous of Kansas," by Mr. W. N. Logan; "The Kansas Niobrara Cretaceous" and "The Pleistocene of Kansas," by Prof. S. W. Williston; and "The McPherson Equus Beds," by Prof. E. Haworth and Mr. J. W. Beede.

The reports are intended for the citizens of Kansas, and therefore parts of some of them are of an elementary character, the rudimentary principles of the subject being explained where explanation is needed to elucidate the facts and render them easily understood by readers who are not trained geologists. This, however, only makes the reports more interesting to the mass of the people of the State, and it is certainly better to obtain geological knowledge through the medium of reports like those in the volume before us than from text-books which give it second-hand.

Forty-eight plates, reproduced by photographic process, illustrate some of the physiographic features of Kansas, and add to the interest of the various papers.

Set of Twelve Diagrams illustrating the Principles of Mining. Arranged by F. T. Howard, M.A., F.G.S., and E. W. Small, M.A., B.Sc., F.G.S. (London: Chapman and Hall, Limited, 1897.)

ARRANGED in accordance with the syllabus of the Department of Science and Art, this admirable set of diagrams will prove of great value to teachers of evening classes in the principles of mining, for there can be no doubt that hitherto the want of suitable wall diagrams has proved a serious obstacle in the way of efficient instruction in this important subject. The diagrams measure 30 by 40 inches, and the subjects dealt with are: (1) the geology of the British Isles, (2) the occurrence of coal and ore deposits, (3 and 4) boring plant, (5) methods

of sinking through watery strata, (6, 7, and 8) methods of supporting excavations and the construction of dams, (9, 10, and 11) methods of working, and (12) pumps and ore dressing. The illustrations have been selected with great care from standard authorities, due acknowledgment of the source being made in each case. The only fault that can be found with the diagrams is, that the authors have covered so wide a field that it has been necessary in some cases for them to crowd together into one diagram too many drawings. The best of the series are the remarkably bold and effective diagrams illustrating methods of working. The least satisfactory are the perspective views of machinery and of timbering. Plans and sections would have been better.

In Northern Spain. By Hans Gadow, M.A., Ph.D., F.R.S. Pp. xvi + 421. With map and eighty-nine illustrations. (London: Adam and Charles Black, 1897.)

THE incidents and impressions of two prolonged journeys through the northern and north-western provinces of Spain are brightly recorded in the volume before us. Personal experiences always have in them the making of an interesting book; and when things are seen with an intellectual eye, and the itinerary refers to places off the beaten track, the narrative is sure to engage attention. The present work, in which the wanderings of Dr. Gadow and his wife are described, possesses both these claims to recognition; moreover, it is well illustrated by camera and pencil. The accounts of the districts traversed, and the notes on the characteristics and customs of the inhabitants, will interest geographers; while archæologists will find a chapter on the Dolmen of Álava, and numerous short descriptions of other interesting antiquities. For students of biological science there are chapters on the fauna and flora of Northern Spain. The former chapter is a valuable analysis of the fauna of the Iberian peninsula.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Highest Kite Ascent.

THE general interest in scientific kite-flying leads me to send the following account of a flight here on September 19, when meteorological records were brought down from the greatest height which it is believed a kite has yet attained. The experiment was part of an investigation into the meteorological conditions of the free air now in progress here, and which is aided by a grant from the Hodgkins Fund of the Smithsonian Institution.

A Richard baro-thermo-hygro-graph (described in *La Nature*, 8 Février, 1896), weighing but 3 lbs., was hung 130 feet below two large Hargrave kites, and other kites were attached at intervals to the four miles of steel wire forming the flying-line, the total sustaining surface of the seven Hargrave kites used being something over 200 square feet. At their highest position the two topmost kites were 9386 feet above Blue Hill, or 10,016 feet above sea-level. The altitudes, at short intervals of time, were obtained from angular measurements with a theodolite, and were confirmed by the barometer record of the meteorograph.

This instrument left the ground about noon, and the greatest height was reached soon after four o'clock, the meteorograph remaining more than a mile above the hill during five hours. A little more than two hours were required for the steam-winch to reel in the four miles of wire, and the meteorograph returned to the ground at 6.40 p.m. The wind on the hill blew from the south with a velocity of about twenty-five miles an hour, but veered to the west in the upper air. The chief results, obtained from the automatic records, which are smooth and distinct, are these:—The temperature at the highest point was 38°, while at the ground at the same time it was 63°, giving a decrease of 1° per 375 feet rise, which is less than normal. The relative humidity at the ground was about 60 per cent. of saturation, but rose rapidly with height to about 4000 feet, which is the level of the cumulus clouds. It then fell, but rose again to nearly saturation above 7000 feet, when approaching the level of the alto-cumulus clouds. The humidity fell to less than 20 per cent. at the highest point reached. Throughout the flight the sky was clear.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, September 23.

Outlying Clusters of the Perseïds.

THE clearness of the sky, and the absence of the moon's light at the end of July and in the beginning of August last, were unusually favourable conditions here for watching the progress of the August meteor-shower of Perseïds from the first signs of its appearance up to very near its date of greatest brightness. Having intended to observe the shower in connection with a watch arranged by Mr. Denning to be kept on the Perseïds this year at many places, and an early beginning of the watch having been recommended, in order to note the progressive changes of the radiant-point's position, I had little expectation of being able to contribute much to this inquiry from the usual scarcity of the Perseïd meteors in the shower's early stages.

A theory of its progressive motion had been formed and compared with observations by the late Dr. Kleiber, of St. Petersburg (*Monthly Notices of the Royal Astronomical Society*, vol. lii. 1891–92, p. 341), depending for its application on certain effects and laws of planetary perturbations. Starting from the same, or from a very similar principle of the effects of planetary disturbances on meteor-orbits with that used by Prof. Adams to calculate the motion of the node of the November meteor-system, that without change of shape or of inclination to the plane of the ecliptic, of the long elliptic orbits round the sun, the line of nodes or intersection of the orbit-plane with the ecliptic is carried secularly backwards or forwards slowly round the ecliptic-circle, according as the motion of the meteors in the orbit is direct or retrograde, Dr. Kleiber showed that the meteors' apparent radiant-point on the earth's encountering the stream, would also be carried with the orbit round the pole of the ecliptic at the same rate in longitude, and without any changes in its apparent latitude. If the earth should thus at any point encounter meteors of the shower which have undergone less or greater secular displacements of their nodes than the main meteor-body, so as to furnish slender meteor-streams observable a few days before or after the principal shower-date, since the earth advances round its orbit through nearly one degree of longitude each day, the differences in longitude between these slender streams and the main stream's radiant-points will evidently be as many degrees, or very nearly as many degrees as the earth takes days to traverse the distances between the outlying meteor-systems and the main one. Tested by this criterion, Dr. Kleiber showed that of forty-nine apparent foci of the Perseïds observed by Mr. Denning, in various years, between July 8 and August 16, forty-six were reducible by applying to all their longitudes the corrections corresponding according to the theory with their dates, to within a circle of only 2° radius round a point at $43°·6, +57°·1$ assigned by Dr. Kleiber as the cometary radiant-point. This surprisingly close agreement certainly afforded a convincing proof of the adequacy of the perturbation theory to explain the recorded changes of position of the Perseïd meteors' radiant-point; but I had been rather sceptical of obtaining from such scanty materials for observations as the very early traces of the Perseïd comet meteors seem to offer, positions of sufficient accuracy to be capable of furnishing with much reliability such a very satisfactory agreement? In a watch of three hours, however, on the exceedingly fine night of July 22 last, seven Perseïds were recorded here, of which two (like two on the 18th and 20th), were directed nearly from the usual shower-centre at about $43°, +57°$, but the other five diverged so distinctly from about $23°, +49°$ near ν and ϕ, at the point, instead of from near χ and η at the handle of the sword of Perseus, that the displacement of the radiant-point at this early date from its usual position to one in, at least, considerably lower right-ascension and declination, was at once very evident, and I was induced to longer watches, on later nights, by this first indication, than I would have thought likely, otherwise to be very usefully productive.

The following short Table (I.) gives a summary of the

TABLE I.—*Observations of Perseïd and Non-Perseïd Meteors in July and August, 1897.*

Dates of the Watches	State of the Sky	Moon's Phase, and Brightness	Hours of Watches; and their Equivalent Durations in a clear dark sky: Hours From	To	Lengths (about)	Numbers of Meteors seen: From the Perseïd Radiants: φ I	4 II	χ III	η IV	B, C Camelopardi V	Total Numbers of Perseïds	Numbers of Sporadic Meteors
			h. m.	h. m.	h.							
1897 July 16	Clear	Gibbous; and bright	10 50	11 50	¾	—	—	—	—	—	—	1
,, 18	Rather hazy	,,	11 15	13 0	1¼	—	—	—	1	—	1	—
,, 20	Very clear	Third qr.; faint	12 0	13 0	¾	—	—	—	—	1	1	3
,, 22	,,	,,	10 30	14 0	3	4	1	—	2	—	7	15
,, 23	Slight cloud	Last crescent; faint	12 50	14 0	¾	—	—	—	—	—	—	3
,, 25	,,	,,	11 0 13 30	11 30 14 0	¾	1	—	—	—	—	1	1
,, 26	Cloudy for 1h.	Faint	11 15	13 45	1½	1	—	—	—	2	3	9
,, 27	Cloudy for 15m.	None	11 15	12 15	¾	3	—	—	—	—	3	8
,, 28	Clear	,,	11 10	12 0	¾	—	—	—	—	—	—	2
,, 30	Very clear	,,	10 20	14 0	3½	—	4	2	1	1	8	12
,, 31	Extremely clear	,,	11 15	13 30	2¼	—	2	—	—	1	3	15
August 1	,,	,,	10 30 11 45	11 30 13 0	2¼	2	—	—	2	—	4	18
,, 2	,,	,,	10 10	14 15	4	1	10	6	1	2	20	14 (one = 3 × ♀.)
,, 3	,,	,,	12 15	14 15	2	1	3	—	2	1	7	12
,, 4	,,	,,	10 45 13 5	11 45 14 35	2½	2	1	2	1	1	7	16
,, 6	Clear	None	11 30	12 30	1	—	—	2	—	4	6	—
,, 8	Cloudy	First qr.; faint	9 5	9 20	¼	—	—	—	1(?)	—	1(?)	1(?), = ♀
,, 8	Clear	None	11 30 13 20	11 45 14 40	1½	3	1	4	3	3	14	11
,, 9	Very clear	Gibbous; weak, till 13h.	9 30 11 0	10 30 14 55	¾ 3¼	2	1	1	14	10	28 (one = ♀.)	26 (one = 4 × ♀.)
Total Length of clear Watch; and Numbers of Meteors seen ..					33½	20	23	17	27	26	113	167

watches kept until August 9, the five radiant-points of the Perseïds which seemed to be certainly determined being noted as I.–V. in the Table, and being also graphically represented in the accompanying Figure (1), of the 113 or 114 tracks of Perseïds which were noted. In another Table (II.) the hourly numbers are shown of the meteors of these Perseïd showers

TABLE II.

Meteor Showers		Approximate Positions of the Radiants. in R.A.	in Decl.	in Long.	in Lat.	Hourly Numbers (near and after midnight), of the Perseïd and Sporadic Meteors seen on Maximum Dates:— 1897, July 22	27	30	1897, August 2	6	8	9
From the Perseïd Radiants	I	23°	+49°	42°	+36°	2	4*	—	—	—	2	—
	II	27	+53½	47	+38	—	—	2	4	—	—	—
	III	36	+55	54	+37	—	—	1	2	2*	3	—
	IV	42	+56	58	+37	<1	—	—	—	—	2	4
	V	51	+57½	64	+37	—	—	—	<1	4*	2	3
All the Perseïd Meteors ...		—	—	—	—	2–3	4*	3	7	6*	9	8
Sporadic Meteors		—	—	—	—	4–5	5–6*	2–3	3–4	—	7	8

* In short Watches of 1h. only.

on the nights of their greatest frequencies, and of sporadic meteors seen on the same nights, using only dark clear hours of the watches from near midnight onwards, to derive the numbers.

The small fireball seen on August 9, at 14h. 18m., lit up the ground with a slight, but sensible illumination, and left a bright streak from 353°, + 5° to 350°, + 1°, which remained visible for three-quarters of a minute. It was not a true Perseïd, but if it was identical with a bright meteor seen at the same hour at Exeter by Mr. Besley, its radiant-point appears to have been near κ and β Persei, at 45°, + 45°. The Venus-like Perseïd which fell at 14h. 43m. on the same night from 88°, + 37° to 98°, + 26°, near Venus, in the East, also left a very dense bright streak, visible for 15 seconds; its apparent course here was straight from η Persei. The equally bright meteor seen in a break between clouds on the previous evening, from 261°, + 26° to 255°, + 10°, at 9h. 10m. (± 3m.), was also true in direction from η Persei, and might be identical with a

meteor of the same appearance seen at 9h. 10m. by Mr. Norman Lattey at Cardiff (*English Mechanic*, vol. lxvi. p. 15, August 20, 1897), if it had left a streak, and had not seemed to move rather more slowly overhead than the swift-flighted Perseïds. The height of its path above the earth would be from 135 to 115 miles if the two meteors really were identical! A more ordinary height of from 81 to 47 miles, was found by Mr. Denning from a second observation of it at Bridgwater, by Mr. Corder, for the non-Perseïd fireball seen here at 13h. 57m. on August 2. This meteor lit up the sky brightly with two concluding flashes, and left a greenish light-streak on the latter portion of its course, visible for 6 seconds. Its radiant-point was found by Mr. Denning, from the double observation, to have been between Aquarius and Aquila, at 312°, ± 0°, on the equator.

Although the watch was not maintained steadily on all fine nights, nor very often for many hours together on the single nights, yet some good views of further frequencies of the Perseïds, with definite centres of radiation, were obtained after the first display from υ, φ Persei on July 22, and were pretty successfully recorded. The latter centre remained active until July 27 (when it was again conspicuous), and then ceased, giving place to a second centre between φ and χ, near 4 Persei, at about 27°, + 53°; although a few Perseïd meteors still now and then appeared to come from the earlier radiant-point position in some later watches.

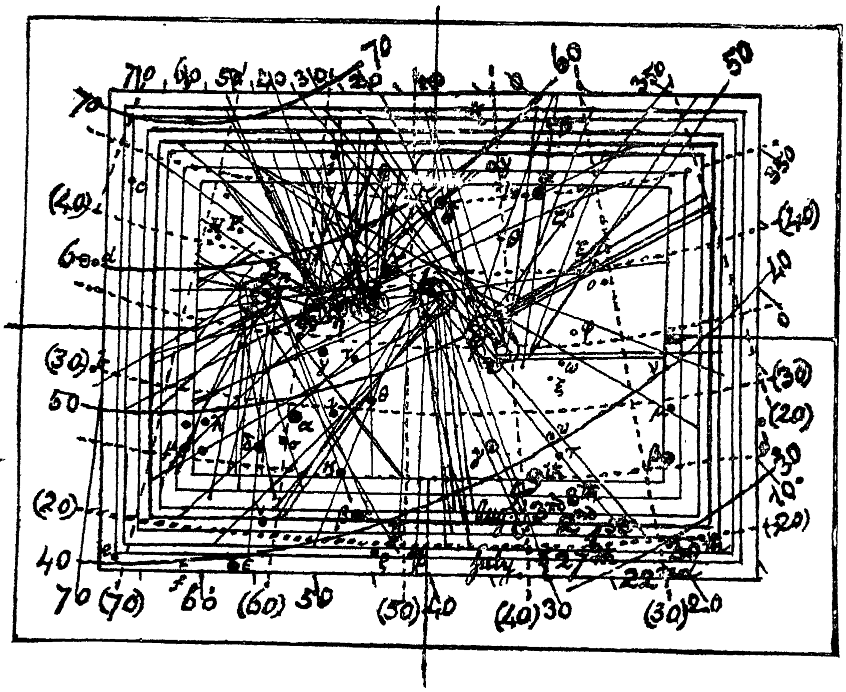


FIG. 1.—Path-lines of Perseïd Meteors belonging to Radiants I. (υ, φ); II. (4); III. (χ); and IV. (η, *k* Persei); and V. (B, C Camelopardi); July 22–August 9, 1897.[1]

The second centre was first well marked on July 30, but it was most active on the beautifully clear night of August 2, with very well-defined radiation from about 30°, + 54°, and with another well-defined and nearly as productive centre near it at 35°, + 56°, whose meteors were afterwards grouped with others (chiefly on August 8) into shower III., at 36°, + 55°. On the two equally fine nights of July 31 and August 1, although sporadic meteors were most plentiful, yet three and four Perseïds only were noted, in watches of 2¼ hours, against 12 Perseïds in the time of watch between the same hours on the later night; and of the twenty Perseïds mapped in 4 hours then, 10 and 6, respectively, proceeded very accurately from the above two companion radiant-points! Like the first shower from φ Persei, the immediately succeeding one at 4 Persei ended in its turn on August 3, and produced only three meteors afterwards on later dates!

Clouds prevented observations on August 5 and 7, but an hour's watch on August 6 showed that the usual stream of Perseïds from the well-known radiant-point in Perseus was approaching, as four of the six Perseïds recorded then, diverged very distinctly from close round B, C Camelopardi.

In watches of two, and of four or five hours' duration, until daybreak, on the nights of August 8 and 9, 42 Perseïd and 37 sporadic meteor tracks were mapped at only the very moderate rates, for so near the epochal date, of eight or nine Perseïds per hour in the closing moonless hours of the two nights' watches; the abundance of the Perseïds on the mornings of August 9 and 10, in fact hardly exceeding the rate very perceptibly (of 7 per hour), which had already been noted a week previously at a similar time of watch on the morning of August 3! On the night of August 10 itself, the clouded state of the sky in England, generally deprived observers here of a view of the shower's appearance on its chief annual date; but from a list of 92 meteor-tracks mapped with nearly cloudless sky in 5½ hours on that night, at Le Havre, in France, which I received from a Member of the Astronomical Society of France, M. Libert, who records appearances of shooting-stars and fireballs at that nearly adjacent continental town to English stations, with extreme care and diligence, sporadic meteors seemed still to be greatly outnumbering the Perseïds, as they did here less strongly on the morning of the 10th, in the proportion of nearly two to one, if even allowances most favourable to the Perseïds are always made in cases where indistinctness of mapping made the radiation doubtful. Substitutions of pointing-stars for the points of first appearance and disappearance, and the abnormal lengths of path thus often noted, which chiefly produced uncertainty in the attempt to assign the meteors their true radiant sources, also prevented any exact positions of the shower's chief centres of divergence on that night from being extracted from the importantly supplied particulars, otherwise, of M. Libert's very valuable and extensive list of path-descriptions.

In point of brightness, however, with seven first-magnitude meteors, and two equal to Sirius or Jupiter, and two compared to Venus, the 25–30 Perseïd shooting-stars described by M. Libert, outshone the 60–65 sporadic meteors, at Le Havre, with their ten of first magnitude and only one each as bright as Sirius and Venus, about as brilliantly as the 28 Perseïds noted here on August 9, with six first-magnitude meteors and one or two each as bright as Sirius and Venus, exceeded the abundance (*pro ratâ*, or doubling the actual numbers here) of bright meteors appearing among the 26 contemporaneously observed non-Perseïd shooting-stars, with three first-magnitude, one Sirius-like, and (possibly) one brighter meteor than Venus, which, however, so nearly came within the range of radiation of the Perseïds that it is also counted in the category above, as possibly a Perseïd fireball.

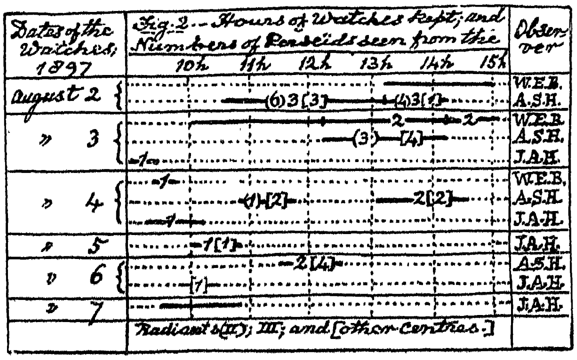
The shower had not yet subsided in numbers or in brightness, it appears, when the strength of the full moon's light had deterred me from looking out for it any longer, on the night of August 11; for in the hour and a half from 10h. 20m. to 11h. 50m. on that night, Mr. J. A. Hardcastle noted at Lymington, in Hants, the paths of ten Perseïds and five sporadic shooting-stars, with two of first magnitude among the former, but none

[1] Circles of Longitude and Latitude are shown by dotted lines (and by figures for every 10°, enclosed in brackets); and circles of Declination by full lines. But to prevent their confusion with path-lines, and their obstructing the view of the path-lines' radiations, the close array of R.A. Meridian-lines is omitted, and the scale of right-ascension is only noted, like the Declination-circles, in plain figures for every 10°, round the border of the Map.

so bright among the latter class of meteors; from which it would appear that the maximum of this year's weak display was probably impending still and not yet arrived at until after day-break on August 11, when at 1h. 45m. a.m. on that morning, M. Libert ended his long watch of the shower on the night of August 10. With one stray flight from ν, ϕ Persei, six of the ten Perseïd meteors seen by Mr. Hardcastle diverged from η, k Persei, and three from B, C, Camelopardi. A bright streak-leaving Perseïd from the latter radiant-point was also noted, with seven non-Perseïd meteors in one hour, at Lymington, as late as the night of August 19.

A long-continued watch was kept for $5\frac{1}{2}$ hours at Exeter, on August 9, by Mr. W. E. Besley, and the paths of 108 meteors were recorded (*English Mechanic*, vol. lxvi. p. 16, August 20, 1897), among whose projections on a map, he states, a very distinct radiant-point of 71 Perseïds was shown at $43\frac{1}{2}°$, $+57°$; extremely near the place, at $43°{\cdot}6$, $+57°{\cdot}1$ assigned by Dr. Kleiber for the cometary main-stream of the shower. No evidences of a companion-stream at B, C Camelopardi seem to have been noticed among the Perseïd-paths by Mr. Besley; though it seems not impossible, in a case of such near contiguity of two co-operating meteor-streams, if only a few, or scattered tracks from the less productive stream, perhaps, were noted, that some real traces of the weaker and diffuser close-adjoining shower's existence, might easily be overpowered and hidden by the close-crowded group of path-lines round the principal shower's centre.

In a previous, almost equally extensive watch, however, kept on the nights of July 30, and August 2-4, at Westminster in London, of the results of which, in the *English Mechanic* (vol. lxv. p. 601, August 13, 1897), Mr. Besley also gave a most



excellent condensed description, 47 meteors were noted at times almost simultaneous, on August 2 and 3 with my watches here; and together with three non-Perseïd radiant points in Triangulum and Andromeda, and near ζ Persei, a distinct radiant-point which Mr. Besley regarded as that of the "true Perseïds," was obtained from five meteor-paths, four on August 3, and one on August 4, at $32\frac{1}{2}°$, $+57\frac{1}{2}°$; only 2° from the place at 35°, +56°, where on the night of August 2 the radiant-point III. first showed itself distinctly in my watches, accompanied by a closely adjoining and equally distinct and productive shower-centre (the shower II.) at 30°, +54°. Although my watch and Mr. Besley's were partly contemporaneous on the night of August 2, when six and ten meteors respectively were noted here from the close pair of radiant-points III. and II., yet the five "true Perseïds" mapped by Mr. Besley were not seen among the 16 meteors whose paths he recorded on that night, but among the 27 noted on the following night and one on the night of August 4. These dates of our recorded maxima seem, however, to have been only apparently in disagreement, because, as the above diagram (Fig. 2) of the hours of watching shows, the rate of appearance of the "χ-Perseïds"[1] was at the most only three per hour, and in the times lost in noting observations, either shower might thus easily pass by unnoticed in a watch, for each of us in turn on those two nights, only barely extending to two hours.

In short watches on August 3, 4, and 5, at Lymington, three meteors proceeding from the "χ-Persei" position were mapped by Mr. J. A. Hardcastle, and a second Perseïd on the latter date from between ν and ϕ Persei. The first two path-lines' directions backwards, passing on either side of χ to a point of intersection at 33°, +54° (about 3° south of χ), and that of the third within 1° east of or preceding χ Persei, through 32°, +57°. One "ϕ-Perseid" and four sporadic meteors were also mapped at Lymington in a short watch on August 6, and nine sporadic meteors, but no shooting-star from Perseus, on August 7!

There seems to be clear evidence in all these observations that pretty conspicuous appearances are observable in July and August, of well-marked brief *battues* of Perseïd shooting-stars, which follow each other in a regular order up to the chief annual display, from about three weeks before it; and additional observations of these feeble meteor-currents will be very useful to determine the exact durations, radiant-point positions and relative intensities as well as variations of intensities in future years, of these weak supplementary streams apparently derived by thinning out of the main current's ring-like, lengthened cluster, on the ring's preceding side.

In the Perseïd meteor-swarm's original progressive lengthening by dissimilar times of revolution and orbit-sizes among its individual meteors, until the slower- and faster-moving stream-ends overlapped each other along the orbit in several repeated circuits, the slightly different-sized orbits must be a little differently affected and impressed with node-line motions by planetary disturbing actions, and they must thus have gradually become very slightly separated from each other. But in the case of any local knot or condensation which the original meteor-cloud may have contained, from the very approximately equal revolution-times and orbit-sizes with which the meteorites in such a small cometary knot or parcel would all set out together from the scene of initial disturbance which first deflected the Tuttle's comet meteor-cluster of Perseïds into its present long-elliptic orbit, the densities and contracted limits of such small groups at intervals along the winding convolutions of the lengthy coil, would naturally still be retained, though less compactly, compared to poorer intervals between them; and weaker annual showers flanking the main one at some constant distances in time and longitude before or after it may thus be expected to be visible, like the present short series of them, or like the larger train of attendant Perseïd-showers which Mr. Denning has recorded, all verifying Dr. Kleiber's view of their origin so exactly by their radiant-point positions.

But the mean rate of motion in longitude of my few observed shower-centres, although also in very distinctly good and notable agreement with the theory, appears to have been a little over-rapid, or about 22° in eighteen days, instead of a little less than 1° *per diem*; and long-maintained activities of the grander central and of the laterally cast-off poorer meteor-streams seemed also in my watches to be as clearly evident and nearly as prominent a property of their radiations as the advance in longitude, both by often noted derivations of single and sparse meteors from them on very different dates from those of the showers' maximum abundances, and more especially by maxima of some of the showers having been noted simultaneously (as those of the showers II. and III. together on August 2, and of showers III., IV., and V. together on August 8 and 9), instead of, as the theory postulates, and as the showers I. and II. exemplified much more distinctly and it may quite possibly be shown hereafter by further better observations, more truly and correctly, with an interval of some few days between them in succession.

The mode of the figure's construction which shows the radiant-point directions of the 114 Perseïd paths recorded, requires a little explanation. As my view of the sky was chiefly overhead (embracing the north pole of the ecliptic the more readily to detect any changes in longitude of the radiant-point's position), the observed meteor-paths from Perseus nearly all shot upwards, and would confuse each other by cross-intersections if it were attempted to represent all the four or five radiant-points together by their means, on a single map. But as only depictions of the path-directions traced back to the several radiant-points, and not of the paths themselves were needed for the figure, these direction-lines only are represented

[1] The star χ, and the conspicuous star-cluster in Perseus in which it appears to the naked eye to be involved, are situated at about $32\frac{1}{4}°$, $+56\frac{3}{4}°$, within 1° of the place assigned by Mr. Besley to the Perseïd radiant-point on August 3-4, and only 2° or 3° from the places which were here obtained for Radiant III., at 35°, +56°, on August 2, and 36°, +55° for July 30-August 8. The star's name may thus be used conveniently, for shortness, as is done above and at a few former places in this *résumé*, to distinguish this radiant-point III. from the earlier Radiant II. near ϕ Persei from July 30 to August 4, which seemed to precede it there quite distinctly and in good agreement with the theory, both in R.A. position and in time.

in their true positions of passing near the several radiant-centres, but directed upwards and downwards alternately, for each radiant-point in turn, so as not very sensibly to confuse each other. The lines are also drawn of such lengths as to show by ending at different border-lines of the diagram, at what date, or approximate date (for the few Perseïds' paths noted on July 20, 23, 25-6, 28, and 31, and on August 4 and 6 are referred to the nearest special dates, by their line-lengths, only) in July or August any path-line was observed. In this way the progress of the radiation is either visible in its main outline at a glance, or any special peculiarities and features of it may be studied closely in detail.

It may thus be noted easily that although not dying out for some days longer, the activity of shower I. was chiefly confined to the first week (up to July 27) of the watch; while the meteors of shower II., first appearing only on July 30, continued, with a maximum on August 2, to show themselves brightly up to August 3; and that little was to be seen of the main stream of η-Perseïds (shower IV.) until August 2-3, when it was still inconspicuous, but when a precursor limb of it, the intermediate shower III., was about as active beside shower II. as it again became afterwards on August 8, but more feebly on August 9, beside the plentiful displays then going on, of the showers IV. and V. from η Persei and B, C Camelopardi.

The offshoot as it seemed of the main shower's radiation, at the latter place, showed like the main stream itself, but slight signs of its existence, either in July or later, until August 6, when four of six meteors (all Perseïds), seen in an hour, diverged very distinctly from a point thus first well indicated near B, C Camelopardi. On the nights of August 8 and 9 it appeared to form an almost equally intense companion-shower to the η-Perseïds: and as it seems to conform well in its position to the straight onward line of motion of the other Perseïd centre-points, and to add apparently another link-step to the regular earlier stages of a chain-like progression, it might have been expected, had the nights of the 10th and 11th of August not been such unfavourable ones for noting any further changes in these loci of divergence, that with the expiration of the η-Perseïd shower IV., the accompanying stream V. from B, C Camelopardi, would perhaps survive it, or else would on some later night reappear with a new and naturally much weaker maximum agreeing with its theoretically proper apparition-date.

Some future years' clear skies, it may be hoped will allow the after-showers of Perseïds, already very clearly and distinctly traced by Mr. Denning, to be seen and noted in not less splendid weather than that which so well and continuously displayed the phases of the preceding showers' appearances in the present year.

Several exceptionally bright meteors, and some smaller ones presenting specially remarkable features of appearance, were noted in my watch, which, together with the real paths obtained from corresponding observations at other places of some of the shooting-stars and fireballs of its list, would furnish me with a sufficient abundance of interesting notes to fill another letter. But the subject of the latter meteors will be discussed more satisfactorily and completely in a general review of the collected observations which Mr. Denning and Mr. Corder are conducting; and satisfactory descriptions of the former meteors would involve more searches among known radiant-points, with full deductions of their radiant-centres for the 167 sporadic meteors of my list, than I have yet attempted, to summarise correctly the points of leading and rather novel interest which were presented by the radiations of some of the more particularly striking meteors. I must forego, therefore, a review of features of interest, and of real path conclusions which some of the individual meteors offered very attractively for description, although I felt at first much prompted to describe them; in order to place their discussion in the hands of those much better and more surely able than myself to judge of their importance, who in combination with Mr. Denning undertook the arduous task of collecting and the necessarily much slower and more dilatory task of abstracting and collating all these numerous descriptions. A. S. HERSCHEL.

Observatory House, Slough, September 21.

A Colony of Highly Phosphorescent Earth-Worms.

IN the sheltered westward corner of a small grass-plat in this city there is a colony of highly phosphorescent earth-worms. The annelid is round, pellucid, slender, of a faint yellowish tint, is about two inches long, and is not flattened behind. I have been unable to distinguish segmentation. The worm is entirely luminous. The phosphorescence has precisely the bright greenish colour of the light emitted by the glow-worm. The light is under control. When in glow its secretion is luminous, as is seen in its trail and in the phosphorescence imparted to the hands when handled. It is said by the owner of the grass-plat that the casts are luminous. This is a point I have had no opportunity of observing.

At night the slightest irritation suffices for lighting-up. I captured one in a small clod of turf, to transplant in my grass-plat. The very slightest pressure of the clod, which I should have thought inappreciable, brought on a manifestation of light. On nights when not on the crawl and not otherwise visible, a favourite expedient is to stamp on the ground to get them to come to the surface. The worms in response at once rise to the surface and light up, as though it were possible for them to show fight, instead of, like other worms, scampering away.

The spot colonised is far from humid, but the worms are more active in wet than in dry weather. The worm is new to this place, and, as far as my researches go, it has not been observed westward in Wales. It seems to me to be an instance of *Lumbricus phosphoreus*, but it hardly agrees with the published description of that organism. I want to avoid depleting the colony, or putting any of the inmates to torture, but I could at least furnish a specimen. J. LLOYD-BOZWARD.

Worcester, September 27

Appearance of a Noddy in Cheshire.

THE other day, when looking through a collection of stuffed birds, I saw and obtained a specimen of the Noddy Tern (*Sterna stolida*, Linn.). It is in immature plumage, the white on the crown being only just visible.

It was shot on the Dee marshes in winter about six years ago.

As I believe this Tern has been only twice recorded as visiting Europe, I think this specimen worth mention.

Neston, Cheshire, September 29. F. CONGREVE.

THE ETNA OBSERVATORY.

A RECENT number of *La Nature* (No. 1262) contains an interesting illustrated account of the observatory on Mount Etna, a building which was originally designed by Prof. Tacchini for some special investigations which he had in hand. The eruption which occurred in 1886 caused much disaster, and considerably affected the building which was not restored till the year 1891. In the observatory at the present time there is an equatorial of 5·5 metres focal length, besides various meteorological and seismographical instruments. Observations are made regularly, except in the winter months. This year a very important addition will be made by the setting up of telegraph and telephone wires as far as Nicolosi, thus rendering it possible to regulate the work.

The ascent from Catania, which town lies at a distance of about 30 kilometres in a southerly direction, is made by coach as far as Nicolosi (700 metres). One proceeds then by mule as far as Casa del Bosco (1440 m.), and to the Alpine meteorological station (1890 m.); this latter place being half-way between Nicolosi and the observatory. The rest of the way is made by foot over the snow; the path, which is very rough, can be ascended by mule in the summer, but it is impossible in the winter, owing to the great accumulation of snow. The observatory is sometimes buried in the snow to a depth of two to five metres, admission being then only possible through the first-floor windows.

The disadvantages of Mount Etna as an observing station are therefore due more to the snow than to volcanic disturbances. Long periods elapse between the volcanic outbreaks, during which time the surface near the central crater and the observatory is quiet, so that even the most sensitive seismograph may be used.

When the outbreaks do occur they are usually very severe, and streams of lava pour down the sides of the mountain, devastating forests, vineyards and fields. Huge boulders, sometimes a cubic yard in volume, are also thrown up.

	Mean temperature.
Winter	−6°·6.
Spring	−1°·5.
Summer	+7°·3
Autumn	+2°·7
The year	+0°·4

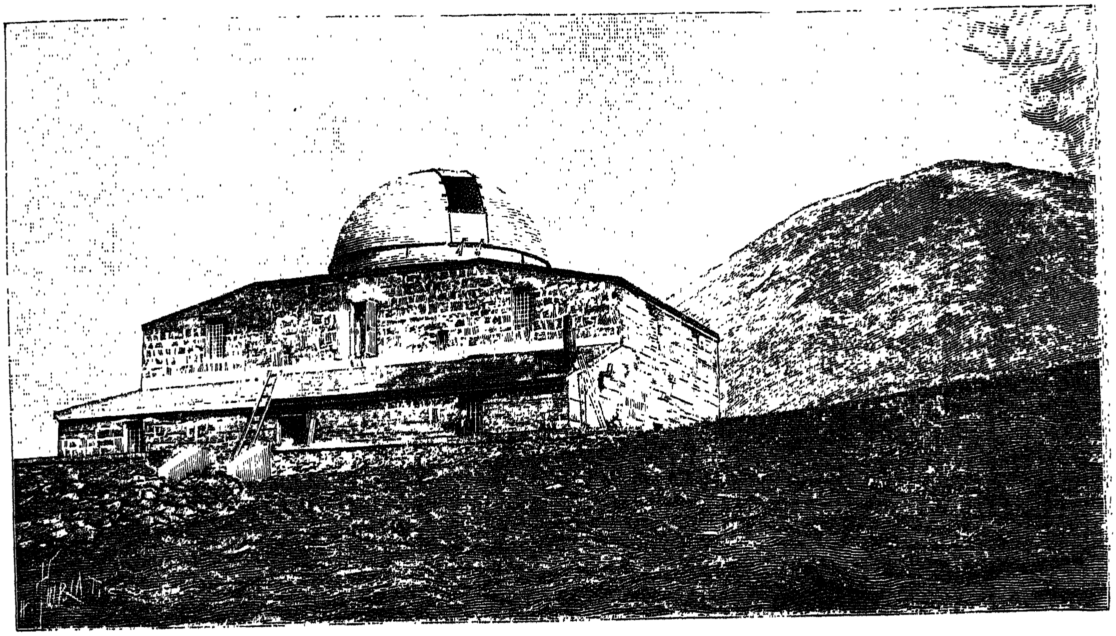


FIG. 1.—The Etna Observatory.

The position of the observatory is as follows:

Altitude	2942 metres.
Latitude	37° 44′·3
Longitude (East)	2° 33′·8 (Rome).

The temperature at the summit ought to be 2°·2 lower than that at the observatory, but observations have shown that it is 0°·6 greater, owing doubtless to the heat of the crater.

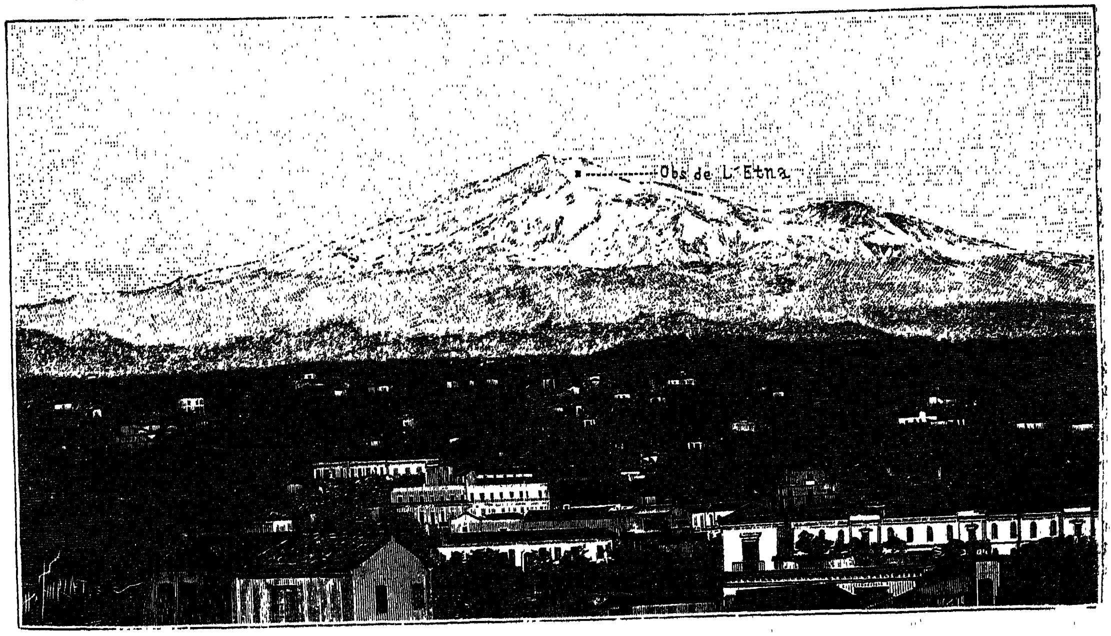


FIG. 2.—Showing the front of the Observatory near the summit of the mountain.

It is situated one kilometre from the central crater, and on the southern side (Figs. 1 and 2). Meteorological observations made since 1892 have given the following mean results :—

Thunderstorms on Mount Etna are not common, and occur chiefly in the autumn. There is no lightning conductor fixed on the observatory, and up to the present time the latter has never been struck, although the large

metallic dome is not in any way connected metallically with the ground. The rareness of thunderstorms is accounted for by the presence of the central crater, the smoke and hot vapour of which act as a lightning conductor on a large scale.

The climate in the neighbourhood of the mountain is of a very varied nature. Except in the summer months the summit is always covered with snow, and it is therefore very cold. At the base, on the other hand, the weather is warm, and the vegetation varies from tropical to arctic species. On ascending the mountain one meets with cacti, oranges, olives, vines, corn, ferns, astragal, chestnut trees and pine trees, up to a height of about 2000 metres. At a higher altitude only rock, volcanic sand, and snow are found.

After an outbreak of the volcano it is natural to suppose that the snow is generally melted by the hot lava. It is of interest, however, to note that a layer of volcanic cinders has been known to protect the snow from lava at a temperature of about 1000°, so that when covered by it the snow was but slightly melted, and the lava formed a black covering in contrast to this white background.

The view from the summit of Mount Etna is described as most magnificent, extending nearly 200 kilometres in all directions. This is due to the fact that the air at this height is reduced to a third of its density, and is of extreme transparency.

FRITZ MÜLLER.

THE death of Dr. Fritz Müller, which took place on May 21 at Blumenau, in South Brazil, has inflicted upon science a loss, the importance of which needs no pointing out. Although the greater part of his life was passed at a distance from the centres of scientific thought, and his natural modesty and self-effacement left him indifferent to his own fame, it has long been recognised that the qualities of observation and interpretation which drew from Darwin the title of "the prince of observers," have earned him a position as one of the greatest and most original naturalists of the century.

Johann Friedrich Theodor Müller was born on March 31, 1822, at Windisch-Holzhausen, in Thuringia, where his father was pastor. After receiving his schooling at Erfurt, he began the study of pharmacy, but shortly afterwards went to Berlin as a pupil of his distinguished namesake, Johannes Müller, the zoologist. As soon as he had taken his doctor's degree, for which he wrote a thesis on the leeches of the neighbourhood of Berlin, he settled at Erfurt as a teacher of science. The occupation, however, proved uncongenial, and he again changed his studies, and turned to medicine, with a view to becoming a ship's surgeon, and thus gaining opportunities for travel and for zoological work in foreign countries. During this early period he began gradually to make a name for himself in science by the occasional publication of various morphological and descriptive papers on leeches and crustacea.

In 1852 the liberal character of his political views brought about a crisis which led to his leaving Germany and betaking himself to Blumenau, on the river Itajahy, just outside the limits of the tropics, where, his education and tastes notwithstanding, he settled down to the occupation of a farmer. Henceforward Brazil was his home, and to this fact and the freedom it brought from the limits set to observation by travel and temporary residence is largely due his distinctive position among naturalists. Under less favourable conditions much of his work, particularly on morphological subjects and on matters involving experiment such as the hybridisation of plants, must have been impracticable. Nevertheless, his expatriation put an end to research for some years, until an appointment as teacher of mathematics at the gymnasium of Desterro, on the island of Sta. Catharina, gave him the wished-for opportunity, and he began assiduously to study the invertebrates of the Brazilian coast, and to overcome the difficulties which the absence of a properly-equipped zoological station and his remoteness from literature and fellow-workers entailed.

From 1857 onwards he published a rapid succession of papers, chiefly in *Wiegmann's Archiv*, on cœlenterates, annelids, and especially crustacea, with the transformations of which he was much occupied. Development, in fact, had at all times a great attraction for him, and he was the first to observe and describe the larval stages of a brachiopod and of *Squilla*. The material for several memoirs was furnished by parasitic forms. He described an anemone, *Philomedusa*, parasitic on a medusa, and made careful studies of such degraded crustacea as *Entoniscus* and *Sacculina*, for the latter of which, together with its allies, he formed the family Rhizocephalidæ. During this period his work was almost entirely concerned with morphological subjects, and it was not until the "Origin of Species" had brought a new interest and significance to the relations between structure and bionomics that he devoted close attention to field observation.

He must have become acquainted with the "Origin" very soon after its publication, and probably received a copy of it from his younger brother and devoted correspondent, Hermann Müller of Lippstadt. His initial attitude towards the book appears to have been critical rather than receptive, for he admits that it was an observation of his own which gave him the first decided impulse in its favour. But he was not long in finding that he could unreservedly accept its principles and devote his energies to their support; and the theory of natural selection gave a definite direction to the whole of his subsequent work.

The observation which determined his adherence to the theory of evolution was the discovery of the nauplius-larva of *Penæus*, a genus of prawns. Important as it is from its bearing on the phylogeny of the crustacea, in which malacostracous nauplius was previously unknown, and its influence on Müller himself, it has not even yet been fully confirmed. Müller succeeded in breeding the protozoæa-stage from his nauplius, but had to build up the further steps in the development from a series of captured examples. Here was room for error, and his account consequently met with a criticism which induced him, in spite of an expressed dislike to going twice over the same ground, to return to the defence of his observations in 1878. Four years later Prof. W. K. Brooks succeeded in rearing *Penæus* from a protozoæa, "identical with that developed by Fritz Müller," but the assumption involved in this statement was such as to prevent the matter from being regarded as settled, and Müller's account, though presumptively correct, is still accepted with reserve by some carcinologists.

The philosophic bent of his mind soon led Müller to recognise the possibility of testing the principles of evolution by applying them towards the building-up of the phylogeny of some group of animals, and ascertaining how far the theoretical results obtained were reconcilable with the observed facts of development. The idea was put into practice for the crustacea in a little book published in 1865, the well-known "Für Darwin," which had a great success in spite of its technical character and limited scope. This success was probably due not merely to the value of its accounts of crustacean development, which embody the main results of Müller's own researches, and the then novel support which the deductive argument brought to evolution, but also to the brilliant simplicity of a title which disclosed nothing beyond the fact of his advocacy and would have served even better to cover the whole of his subsequent writings. At that time the principle of evolution itself was at stake,

and the book is essentially an argument for it, rather than for natural selection, in support of which as distinct from other suggested agencies it advances comparatively little.

Its publication naturally aroused Darwin's interest; he quoted freely from it in the later editions of the "Origin," and arranged for its appearance in an English translation. This was made by Mr. W. S. Dallas, and published in 1869 under the somewhat less forcible title of "Facts and Arguments for Darwin." It materially increased the reputation which Müller had gained in this country during the preceding twelve years by the appearance in the "Annals and Magazine of Natural History" of translations or abstracts of his chief papers, also from the pen of Mr. Dallas.

The most important result, however, of "Für Darwin" was that it led Darwin to address to Fritz Müller in August 1865, the first of the long series of letters which passed between the two naturalists. Mr. Francis Darwin has put on record his recollection of the pleasure which his father took in this correspondence, and his impression that of all unseen friends Müller was the one for whom his father had the strongest regard. Closely in touch with nature as Müller was, his was exactly the adherence which was most welcome to Darwin, who so directly recognised the affinity in character and mental outlook between himself and his correspondent that, in asking for Müller's opinion on pangenesis, he wrote: "I value your opinion more than that of almost any one. . . I feel sure that our minds are somewhat alike."

Some of the letters written by Müller were sent for publication to NATURE; from these as well as from the references in Darwin's published correspondence and books, particularly "The Forms of Flowers" and "Cross and Self-Fertilisation of Plants," some idea can be formed of the abundance of new and interesting observations on all sorts of subjects, largely botanical, which Müller made and communicated. These letters, which drew from Darwin the exclamation: "Heaven knows whether I shall ever live to make use of half the valuable facts which you have communicated to me," show, even better than his papers, Müller's insight into and sympathy with Darwin's work, and his consequent tendency to be always on the look-out for any peculiarity of structure or habits that could be interpreted by natural selection.

Thus, when in the controversy as to the existence of the insect required, *ex hypothesi*, to reach the nectary of *Angræcum*, it was contended that no existing moth possessed a proboscis of the necessary length—about eleven inches—Müller entirely disposed of the contention by forwarding the proboscis belonging to an undetermined Brazilian *Sphinx*, of the length required, to his brother, who described and figured it in these columns.

In 1867 the increasing influence of the Jesuits compelled Müller to leave Desterro, and he returned to the occupation of a farmer, a change which brought his work on marine zoology to an end. At this time he was appointed naturalist to the Brazilian Government, and somewhat modified the range of his studies, occupying himself with entomology and botany, and applying a more systematic attention to bionomics and field observation. Although often looked upon as mainly an entomologist, he published nothing on insects during the first thirty years of his career. In 1873, however, he began a series of papers on Termites in the *Jenaische Zeitschrift*; these contain some of his most brilliant conceptions in the theories put forward as to the existence and function of the supplementary reproductive forms and the uselessness of the true imagos, as well as in the comparison of the two kinds with cleistogamic and perfect flowers. Although the facts at his disposal were insufficient to enable him to confirm his theories, they formed the foundation on which Prof. Grassi has since successfully built, and which he has appropriately acknowledged by the dedication of his monograph to his predecessor.

Fritz Müller's most familiar entomological work is certainly that on mimicry. The original theory of Bates failed to suggest any explanation of the most striking class of resemblances found among butterflies, those subsisting between pairs or among groups of what are regarded as protected forms, and was open to criticism on several points for want of evidence. Bates, it must be recollected, did not elaborate it on the Amazons, but after his return to England, when all opportunity of specially directed observation had ceased for him. Müller first dealt with the possibility of the origin by gradual stages of a mimetic from a non-mimetic pattern, a point left so little treated as to have invited scepticism; but his work, though sound in principle, suffered from a want of familiarity with the range of form in the genera discussed, which only the resources of a museum could remedy, and the idea has been recently worked out more exhaustively by Dr. Dixey.

In 1879 Müller published in "Kosmos," to which he had been a regular contributor from the first, the well-known hypothesis framed to supplement that of Bates, and based on the assumption that a bird learns to recognise and avoid an unpalatable species of butterfly as the outcome of a series of experiments. The toll thus taken must stand in relation to the number of birds and not of butterflies, and would therefore be distributed over two or more species of the latter by their acquisition of a common appearance, a fraction only of the loss falling on each component of such a group.

The "Müllerian theory," though destined to perpetuate its author's name, is scarcely typical of his work in so far as it is an ingenious speculation, not dependent on direct observation, but one which could have been evolved by a naturalist who had never seen a living example of the insects it deals with. Still, it remains the first and only serious attempt to bring an intractable class of facts within the scope of natural selection, and, even if it should be ultimately superseded, it will have immensely advanced the study of these wonderful resemblances.

The paper containing Müller's article was sent by Darwin to Prof. Meldola, then Secretary of the Entomological Society of London, who recognised its importance, and at once published a translation. The theory, however, met with much opposition, including that of Bates himself, then somewhat past the reception of new ideas, but to its author's great gratification it found a warm supporter in Dr. Wallace, whose adhesion involved the abandonment of an earlier view that these resemblances were due to unknown local conditions. Three years later this view was strenuously combated by Müller in an important but untranslated, and therefore less familiar, article. To accept its main argument, that these likenesses result from some process of visual selection—and it has never been seriously answered—does not compel belief in a destructive process. Though Müller suggests no alternative in his paper, he appears to have held and privately put forward the idea that another factor, that of direct selection or segregation on the part of the insects themselves, might play some part. He paid a large amount of attention to the scent-tufts, odours and other means of recognition in butterflies, and at a somewhat earlier period had so far expressed his views that we find Darwin writing to him in 1871 ("Life and Letters of Charles Darwin," iii. p. 151): "Would you object to my giving some such sentence as follows: 'F. Müller suspects that sexual selection may have come into play, in aid of protective imitation, in a very peculiar manner, which will appear extremely improbable to those who do not fully believe in sexual selection. It is that the appreciation of certain colour is developed in those species which frequently behold other species thus ornamented.'" Granted that this was a somewhat

fanciful speculation, it is at least significant that it should have presented no improbability to the mind of an observer before whom the insects concerned were constantly present as a living reality.

The work on mimicry was brought to a close with the account, published in 1883, of the torn wings collected from specimens of an inedible butterfly, *Acræa thalia*, in order to show that a protected insect was not immune from tentative attacks on the part of birds. Still, even if the evidence thereon be regarded as conclusive, it scarcely indicates the difference in amount between the attacks made on protected and unprotected species respectively, which must exist under Müller's hypothesis. And in view of the doubts which have been expressed by competent observers as to the prevalence of butterfly-destruction on the part of birds, the subject calls for further and more exhaustive investigation. Since Müller's work, little progress has been made on the study of mimicry by observations on the living forms.

Amongst the many other entomological subjects investigated by him are cases of dimorphism in fig-insects and in gnats, in a species of which he found two kinds of females, one large-eyed and honey-sucking, the other small-eyed and blood-sucking; the case-making of Phryganeidæ and the development, in some cases very remarkable, of several species of aquatic insects. As recently as 1895 he published in the *Transactions* of the Entomological Society of London a paper on the metamorphoses of an aquatic fly, the material for which, however, had been worked out some fourteen years previously, when the drawings were made. These are, perhaps, the best published examples of his skill as a draughtsman.

In botany Müller's work, like that of his brother, the author of "Die Befruchtung der Blumen," deals mainly with the fertilisation of plants, and includes a number of important observations on heterostylism, hybridisation and self-sterility, many of which are recorded in Darwin's "Animals and Plants under Domestication" and "Cross and Self-fertilisation of Plants." The experimental results obtained, *e.g.* in the fertilisation of orchids, are of great interest; in a series of cases he was able to establish a progressive gradation in self-sterility from species in which the flower was sterile to its own pollen but not to that taken from other flowers on the same plant, up to those in which entire fertility was only to be obtained by crossing, the pollen of a different species being prepotent. Most remarkable of all, in certain species the pollen of a flower was found actually to have a destructive effect upon its own stigma.

His later years were mainly given over to botanical studies, but the period was clouded with a succession of misfortunes which he bore courageously, not losing his interest in research, although his activity was diminished. For him science meant the advancement of knowledge, and he looked for no practical benefits for himself from it. Assuredly they did not come unsought. As far back as 1880 he suffered gravely from the destruction of his property by a flood, a loss which drew from Darwin a touching expression of sympathy and a desire to aid. At a later period the Brazilian Government, with singular illiberality, deprived him of his post without pensioning him, and left him in straitened circumstances; and as recently as 1894 he was imprisoned by rebels and tried by court-martial. In the same year the death of his wife took place, but the bereavement, heavy as it was, did not affect him so deeply as did the loss of a beloved daughter, herself an excellent observer, who, at eleven years of age, discovered the circumnutation of *Linum*. She died at Berlin, and the blow deprived her father for a long time of all desire for work. But his indomitable enthusiasm overcame even this trouble, and his researches were carried on up to the last year of his life.

To call Müller by Darwin's happily-bestowed title is to recognise not merely the energy, perseverance and capacity for observation which he brought to his work, but also the discrimination which led him to the choice of subjects for study and the closely-reasoned and philosophic interpretation of his results. If his name is not associated with any marked advance in thought, except on one or two special questions connected with natural selection, it is because he found his intellectual faith in the theory which he set himself to developing and strengthening. He was content, in fact, to assist in the building of the structure of which another was architect, and in this task his services have been great. It may be questioned whether any other naturalist, save Darwin himself, has given the world so large and original a mass of observations of the kind by which natural selection has been most strongly supported.

To take a just and comprehensive survey of his labours is by no means easy. His papers are scattered through many journals, and a full bibliography of them is as yet wanting; even the list, down to 1883, given in the "Royal Society Catalogue of Scientific Papers" is incomplete, omitting as it does all his contributions to "Kosmos." Moreover, they cover a wider range than most naturalists take for their province, and yet are far from containing the whole of his results. Not a few of his notes have been made public by the friends to whom he communicated them with characteristic generosity; others still lie buried in his letters and memoranda. And a reference to such papers as those on mimicry makes it plain that but a part of his published observations have found their way into common scientific knowledge, and many still wait to be incorporated into the fabric of biology.

More than five-and-twenty years have passed since Darwin wrote to Müller: "I earnestly hope that you will keep notes of all your letters, and that some day you will publish a book, 'Notes of a Naturalist in S. Brazil,' or some such title." But the idea did not attract, and the wish, though echoed by many friends, was destined to remain unfulfilled. One can therefore but express the hope that, now that his labours are ended, such a record of them may be given to the world as shall form a worthy memorial of so earnest and single-minded a lover of nature.

W. F. H. B.

NOTES.

WE invite attention to the change of address of the publishers of NATURE, announced in our advertisement columns. After Saturday next, October 9, all communications for the editor of NATURE should be sent to St. Martin's Street, London, W.C.

WE regret to announce that Dr. Charles Smart Roy, F.R.S., of Trinity College, Professor of Pathology in the University of Cambridge, died on Monday night, at the age of forty-three years.

THE Accademia dei Lincei have just elected Prof. G. H. Darwin, F.R.S., and the Right Hon. G. J. Goschen, M.P., F.R.S., foreign members of the Academy.

IT is stated in the *Athenæum* that the well-known Dr. Adolf Harnack is engaged on a "History of the Prussian Academy of Sciences," which is to appear in the year 1900, the two hundredth anniversary of its foundation.

THE annual address of the President of the Royal Photographic Society will be delivered at the meeting of the Society on Tuesday next, October 12. The presentation of the medals will take place on the same evening.

THE *Geological Magazine* makes the following announcement with reference to the forest-bed of the Norfolk coast:—This interesting deposit, so rich in organic remains, has been care-

fully worked for more than twenty years by Mr. A. C. Savin, of Cromer, who during that period had accumulated about 1900 specimens of Vertebrata, many of which had been described and figured by Mr. E. T. Newton, F.R.S., Prof. Leith Adams, Prof. Lankester, F.R.S., and others. Mr. Savin's collection has just been acquired by the British Museum (Natural History), where it will be preserved for all time, and form a most unique and valuable addition to our National Museum, as well as add greatly to our knowledge of the fauna of this old Pliocene land-surface.

THE *Forres, Elgin, and Nairn Gazette* contains a paragraph to the effect that within the last few weeks, by the kindness of Lady Prestwich and the Trustees of the British Museum, an interesting and instructive series of fossils, ranging through the whole scale of the fossiliferous rocks and consisting of 833 specimens, has been presented to the Falconer Museum at Forres. This valuable collection has been systematically arranged by Mr. Bullen Newton, of the British Museum, and it forms an addition of great educational value to the contents of the Falconer Museum. The thanks of the Trustees and Managers of the Falconer Museum are due to the authorities of the British Museum for their generosity, but especially to Lady Prestwich, to whose interest in the Museum, which was erected by funds bequeathed for the purpose by her uncles, they are mainly indebted for this valuable gift.

THE death is announced of the Rev. Andrew Matthews, distinguished for his work on micro-coleoptera. We learn from the *Entomologist* that in 1872 Mr. Matthews published the first volume of "Trichopterygia illustrata et descripta," with thirty-one plates drawn by himself; and in his eightieth year he completed a second volume, also illustrated by his own hand: this is now with the publisher. Among his other works are papers on the genera *Hydroscapha, Amblyopinus, Myllæna*; and synopses of the Trichopterygidæ of Europe and North America. He also described the species of his particular group of Coleoptera in "Biologia Centrali Americana."

THE North German Lloyd Steamer, *Kaiser Wilhelm der Grosse*, which has recently made the record passage for speed on her maiden voyage from Southampton to New York in 5 days 22 hours, or an average of 21·39 knots, is the largest passenger steamer afloat. Her dimensions, however, will be exceeded by the *Oceanic*, now building for the White Star Company by Messrs. Harland and Wolff at Belfast, and which is expected to be ready for launching at the beginning of next year. The length of this vessel will be 704 feet, or 25 feet longer than the ill-fated *Great Eastern*, and 55 feet longer than the *Kaiser Wilhelm*. Her gross tonnage will be 17,000 and she is to be adapted for use as an armed cruiser, her coal-carrying capacity when so used being, at a speed of 12 knots, sufficient for 23,400 miles, or practically for a voyage round the world. The speed, when in use for passenger traffic to and from New York, is, as at present designed, to give an average of 21 knots.

AN international conference of leather trades chemists, held on Tuesday and Wednesday, September 28 and 29, at Herold's Institute, Bermondsey (Leathersellers' Company's Tanning School), and at which Great Britain, the United States of America, Austria, Denmark, France, Germany, Norway and Sweden were the countries represented, concluded its proceedings on the 30th ult., by a joint meeting of the leather trade and its allies at Leathersellers' Hall, kindly lent by the Worshipful Company of Leathersellers. The object of the conference was chiefly to arrive at uniformity in the matter of tanning analyses, and to formally establish an International Association of Leather Trades Chemists. The conference was opened by Mr. C. T. Millis, Principal of Herold's Institute, and representing the Governors of the Borough Polytechnic, of which the Institute is a branch; the chair being afterwards taken by Dr. Perkin, F.R.S. The Right Hon. W. L. Jackson presided at the Leathersellers' Hall meeting. As the first president of the International Association, the conference elected Mr. Alfred Seymour-Jones; as honorary secretaries, Prof. H. R. Procter (Yorkshire College, Leeds) and Dr. J. Gordon Parker (Herold's Institute, London).

THE *Times* prints the following dispatches, received from its correspondent at Melbourne: October 3: "The scientific expedition which was despatched to the Ellice Islands by the Sydney Geographical Society, under Prof. David, has confirmed Darwin's theory of the formation of coral islands. Prof. David reports from Samoa that the expedition has been a decided success. The diamond drill went down 557 feet in the coral without reaching the bottom." October 4: "With reference to the borings on the Ellice Islands to obtain information as to the formation of coral islands, Prof. David states that the results to 487 feet were inconclusive. Beyond that, they strongly favour Darwin's theory, though a final judgment depends upon microscopic examination of the drill cores. The borings are being continued." Miss E. Walker contributed 500*l.* towards the expenses of this expedition, and the Royal Society 100*l.* directly, and probably another 100*l.* through its coral-boring committee. The expedition was under the auspices of the Royal Geographical Society of Australasia, and was directed by Prof. T. W. E. David, of Sydney. In view of the difficulties previously met with at Funafuti, a special boring plant was provided weighing over 25 tons, and capable of boring to a depth of 1000 feet. It is understood that the core obtained will be forwarded first to the Royal Society of London, which will return one-half to the Royal Geographical Society of Australasia.

THE Beavers exhibited in the Zoological Gardens are mostly of the American species (*Castor canadensis*), though specimens of the European form (*C. fiber*) have been occasionally obtained from the Lower Rhone, and Beavers are still to be met with in some districts on the Elbe and on the Danube. An excellent memoir lately issued by Prof. Collett, of Christiania ("Bæveren i Norge"), gives us an account of the Beavers still remaining in Norway, where it had formerly a very extended distribution. Prof. Collett thinks that in all probability the Beaver will last in Norway in a state of nature "well into the next century," provided a small amount of care is taken to protect it. The number of individuals existing in Norway at present he estimates as about 100. In 1880 Mr. Cocks considered that there were only about 60, so that there may have been a slight increase in recent years.

UNDER the name *Hylobates henrici*, M. E. de Pousargues describes a new species of Gibbon from the interior of Tonquin. It is based on a skin presented to the Muséum d'Histoire naturelle of Paris by Prince Henry of Orleans, which was obtained by the Prince in 1892 at Lai-Chan, a little to the north of the Black River of Tonquin, and not far from the frontier of the Chinese province of Yunan.

MR. H. SAVAGE LANDOR, who left England in March last, commissioned by Mr. Harmsworth, the proprietor of the *Daily Mail*, to endeavour to enter the sacred city of Lhassa, in Tibet, has not been successful in his undertaking. News has just been received that a few days after crossing the frontier of Tibet, disguised as a Chinese pilgrim, all except two of Mr. Landor's men abandoned him. In spite of this, Mr. Landor continued on his journey, but eventually he lost all his provisions, and by an act of treachery was made a prisoner by the Tibetans. He was sentenced to be beheaded, but at the last moment the Grand

Lama stopped the executioner, and commuted the sentence of decapitation to the torture of the stretching log—a kind of rack upon which Mr. Landor was chained for eight days—after which he was released. Mr. Landor has now returned to India, suffering from the effects of the torture to which he was subjected, and which he half anticipated before he set out upon his hazardous journey.

A CURIOUS illustration of the power of light matter to perforate more substantial substances when driven at a high velocity is stated by the *Engineer* to have occurred in the Royal Arsenal a few days ago. In the course of experiments on firing gas in mines, conducted by Captain Cooper Key, R.A., under the Home Office, a special gun is employed to do duty for a bore-hole with a charge of high explosive, and pressed cylinders of raw dry clay 3 in. long and $1\frac{5}{8}$ in. in diameter are used to represent tamping. These "shots" are made to act in various mixtures of air, coal-dust, gas, &c., and to stop the course of plug, &c., eventually, a cast-iron target plate, 1 in. thick, was placed 25 ft. in front, at an angle of 45°, in order to break up everything into dust and throw it upwards. After three or four shots with this arrangement the clay plug, weighing $7\frac{1}{2}$ ozs., perforated the inch iron plate, and the hole thus made has been steadily extended since. The familiar tallow candle passing through a door must hide its head before a $7\frac{1}{2}$-oz. plug of clay perforating an iron plate an inch thick at an angle of 45°. Doubtless the velocity must be tremendous. It is pointed out that the velocity for a hard cylinder of this weight and size to cut through an inch of wrought iron at 45° would be over 1800 foot-seconds. With cast-iron and clay and the three or four repeated blows, everything is so greatly altered that there is little more to be said than that the effect is remarkable and unexpected.

AN important contribution to the controversy respecting the great Alpine double-fold has been issued by Dr. Rothpletz of Munich, in the last number of the *Zeit. deut. geol. Gesell.* (vol. xlix. pp. 1-17). In this paper Rothpletz examines in detail the evidence which led the orthodox school of Swiss geologists to the belief that the Glärnisch massif has been formed by a double fold. It is well known from Heim's great work, the "Mechanismus der Gebirgsbildung," that the summit of the Glärnisch consists of Lower Cretaceous rocks, which rest on deposits belonging to a later part of the same system. Baltzer accordingly explained this inversion by a complex series of folds and double folds. Rothpletz, however, by a magnificent piece of detailed field-work, has shown that the arrangement can be more easily explained as a case of over-thrust faulting. The Glärnisch, it may be added, stands on the western border of the mountain group, whose complicated structure Heim's double-fold of Glarus was invoked to explain.

A SYNOPSIS of a report on an experimental boring for petroleum, carried out by Mr. W. A. Fraser at Athabasca Landing, Alberta district, is given by Dr. G. M. Dawson in the Annual Report (vol. viii.) recently issued by the Geological Survey of Canada. Where the basal sandstone of the Cretaceous formation comes to the surface, about 130 miles north of the place of the boring on the Athabasca River, it is charged with bituminous matter, and from the observed dip of the Cretaceous rocks it was hoped that these "tar sands" would be found at a depth of from 1200 to 1500 feet. This estimate has proved to be a little under the mark, but the work that has been done indicates that the top of the tar sands should be reached at about 1800 feet. When Dr. Dawson visited the boring, a depth of 1731 feet had been reached, and it was proposed to continue down to 2000 feet, so as not only to pass through the tar sands, but also to penetrate, for some distance, the rocks—presumably limestones of Devonian age—underlying them. It is pointed out that there can be no reasonable doubt that an important oil-field exists in northern Alberta and Athabasca, and the facts gained by the experimental boring of the Canadian Geological Survey has rendered it possible to estimate very closely the depth at which the tar sands may be looked for along the Athabasca Valley for a distance of about 150 miles. The development of deposits of petroleum in this region is of such great importance that Dr. Dawson should not lack support in the plan he advocates of sinking several experimental wells simultaneously in different parts of the great area, which the geological conditions show to be favourable to the occurrence of petroleum in quantities of commercial value.

THE Explosives Department of the Home Office has (says the *Times*) recently had under consideration the question of the restrictions to be applied to the manufacture and keeping of acetylene gas, and has conducted various experiments with the object of gaining information on this matter. The results show conclusively that acetylene gas *per se*, when under a pressure of something less than two atmospheres, is violently explosive; whereas at a pressure less than one a half atmospheres it appears to be reasonably free from liability to explosion, provided it is not admixed with oxygen or atmospheric air. For commercial and practical purposes it is considered sufficient to allow a pressure of 20 inches of water above that of the atmosphere (*i.e.* roughly about one and one-twentieth atmospheres), and it is accordingly proposed to draw the safety line at this point, and to declare acetylene when subject to a higher pressure to be an "explosive" within the meaning of the Explosives Act, 1875. In France and Germany, the authorities have fixed the limit of danger at one and a half and one and one-tenth atmospheres respectively, and have imposed prohibitions or restrictions on the keeping or manufacture of the gas when it is at a higher pressure.

DR. AL. BLUDAU publishes in *Petermann's Mittheilungen* (viii. 1897) a second instalment of his work on the measurement of the great drainage basins of the world. Dealing this time with Africa, he discusses in detail some of the divisions offering special difficulty in definition, and finds that of the total area of 29·3 millions of square kilometres, 36 per cent. drain to the Atlantic, 15 per cent. to the Mediterranean, and 18 per cent. to the Indian Ocean, while the neutral regions form the remaining 31 per cent., the Sahara alone occupying six and three-quarter millions of square kilometres.

A BRIEF preliminary report by the surviving officers of the second Bottego Expedition in Somaliland, Lieuts. Vannutelli and Citerni, with a route map, is contained in a recent bulletin of the Italian Geographical Society. The expedition started from Brava in October 1895, and reached the north end of Lake Rudolf in August 1896, whence Dr. Sacchi set out in the November following, intending to return southwards with the zoological and ethnographical collections; his fate seems still very uncertain. The main body of the expedition left the camp on Lake Rudolf about the same time, and skirted the Ethiopian highlands, travelling in a north-westerly direction; but owing to the unhealthy climate Captain Bottego was compelled to make for the mountains, where he had dealings with the chief of Lega and Sajo, who, however, proved treacherous, and in the fight which ensued Captain Bottego lost his life. The survivors were kept prisoners for a time, but were ultimately sent to Adis Abeba by the Emperor Menelik.

IN the *Bollettino della Società geografica Italiana*, Signor G. Roncagli discusses the tides of the Straits of Magellan between Cape de las Virgines and Punta Arenas, the special question being the retardation of the tidal stream by some three hours in mid-channel, compared with the shore on either side, first pointed out by King and Fitzroy. He suggests as an explanation of the phenomenon, that on account of the peculiar shape of the channel a gravity current is superposed on the normal

tidal stream, in such a manner that while at the sides the tide presents the ordinary phases, in the centre the gravitational movement is first against the tidal movement, then in equilibrium with it, giving slack water for a longer or shorter period, and finally in the same direction with it.

An account of the quantity and value of the minerals obtained from mines, quarries, brine-works, &c., in the United Kingdom, during the year 1896, is given in a Blue Book just issued by the Home Office. Many facts of interest are contained in the report, in addition to the statistical information; but the limitations of space will only permit us to refer to a few of them. In 1896 the total output of coal was 195,361,260 tons; of this amount, 9309 tons were obtained from open quarries. The seams worked in England vary from eleven or twelve inches to thirty feet in thickness, and in Scotland seams of cannel coal only six inches in thickness are being worked. The only mine worked for cobalt and nickel ore is in Flintshire; and, after being idle for several years, it has lately been re-opened. The mine affords an instance of the occurrence of the mineral asbolane with red clay in irregular cavities in the carboniferous limestone. Copper mining is rapidly decreasing in importance in Britain, only 9168 tons having been produced in 1896, whereas the output in 1863 was 210,000 tons. Flint-mining still survives at Brandon, in Suffolk; the produce of a few shallow mines worked in a most primitive fashion suffices to supply the gradually diminishing demand for gun flints, which are exported to savage countries. Referring to gold ore, the report points out that, compared with the yield of the colonies and many countries, the amount of gold obtained in Britain is insignificant; nevertheless, mineral veins in North Wales have from time to time furnished considerable quantities of rich auriferous quartz. In 1896 the five mines in Merionethshire produced 2765 tons of ore, from which 1352½ ounces of gold, having a value of 5035*l.* were obtained. This, however, is a much lower output than that of the previous year. The principal iron-producing districts at the present time are Cleveland or North Yorkshire, yielding over five million tons annually, and Cumberland and North Lancashire, with an output of over two million tons. The Cleveland ore is an earthy carbonate containing about 30 per cent. of metal, while the red hæmatite of the two other counties yields 50 to 60 per cent. The total quantity of iron ore obtained from our mines and quarries last year was twelve and a half million tons. Appended to the report are tables showing the production of minerals in the British Colonies and Dependencies.

The Weekly Weather Reports issued by the Meteorological Office show that for the nine months ending with September the rainfall had reached or exceeded the average in all districts of the United Kingdom, except in Scotland. The greatest excess has occurred in the south-west of England, where it amounts to six inches, and in Ireland. During the severe thunderstorm which occurred over the southern and eastern parts of England at the close of the month, amounts exceeding an inch were recorded at many places, the fall in the metropolis (1·03 inch) being the greatest in twenty-four hours since the beginning of the year; about one and a half inches fell at Cambridge, being about three parts of the mean for the month, and over two inches at Hillington (Norfolk). The greatest deficiency (2·7 inch) is in the north of Scotland, notwithstanding that more than an inch fell at some places in the twenty-four hours ending on the morning of September 30, during which period the heavy storms occurred in the south of England.

We have received from Prof. A. Klossovsky a copy of the *Annales* of the Odessa Observatory, for the year 1896. One of the most serious operations during the year has been the erection of magnetic variation instruments in an underground room of the observatory. In this work the valuable assistance of Dr. Leyst, of the Pavlovsk Observatory, has been obtained. In addition to the usual meteorological and magnetic observations, a special study has been made of the movement and height of the clouds during the year, in accordance with the scheme of the International Meteorological Committee. Some interesting experiments have also been made upon the ascending and descending currents of the atmosphere by means of an anemometer turning in a vertical direction. The results show that in the diurnal period the ascending currents are more frequent than the descending, the hours being in the proportion of 8 : 1. The maximum motion occurs at 1h. p.m., and the minimum at 4h. a.m. The regular staff of the observatory, two in number, is absurdly small for the amount of good work done; the publication of the results is due to the liberality of the Municipality of Odessa.

The South Saxons have been investigated by Mr. R. J. Horton-Smith (*Journ. Anth. Inst.* xxvi. p. 81). His studies are based on a collection of fourteen skulls, excavated by Mr. C. H. Read at Goring in Sussex, the associated ornaments proving them to be of early Saxon age. This collection was supplemented by a study of West Saxon, East Anglian, and other British skulls in the Cambridge Museum. Mr. Horton-Smith arrives at the following conclusions:—The South Saxons in Britain were not an absolutely pure race, but had a little British blood in them. The Wessex Saxons were still less pure, owing to their more frequent intermarriage with the British population. Dr. Beddoe's researches are confirmed that the pre-Saxon population predominates in the upper valley of the Bristol Avon; but the population of the Cirencester district is chiefly Saxon, though containing a slightly larger admixture of British blood than is the case in East and South Wessex. The East Anglians have a form of skull slightly different from that of the South Saxons. It is rather broader, less flattened, the orbits are higher, the face relatively longer, and the cranial capacity larger. Mr. Park-Harrison believed that the projecting (prosopic) nose of the modern English was derived from the Angles, and not from the Saxons. According to Mr. Horton-Smith's observations the reverse is the case.

A bacterial disease of the common "squash-bug," *Anasa tristis*, has been studied by Mr. B. M. Duggan at the Illinois State Laboratory. It is readily communicated to "chinch-bugs," and is the first genuine bacterial disease of hemipterous insects known. The parasite has been named *Bacillus entomotoxicon*. A disease which attacks the capsules of the cotton-plant in Alabama has also been worked out in the Agricultural Experiment Station at Auburn, Ala., by Mr. J. M. Stedman, and is referred to a hitherto undescribed microbe, which he names *Bacillus gossypinus*.

We have received a copy of "Botanical Observations on the Azores," by William Trelease (from the eighth annual report of the Missouri Botanical Garden). The observations were made and specimens collected in order to obtain information as to the endemic and naturalised flora of the Azores group. Very few of the species described are, however, endemic, most of the existing species having evidently been introduced by drift, migratory birds, &c., and by human agency since the discovery of the islands. Mr. Trelease remarks: "Though it might, perhaps, be expected, no differentiation has yet been shown comparable with that seen in the plants of different islands of the Galapagos group in the Pacific, where specific or varietal differentiation is strongly marked, but where communication between the several islands is far more restricted than in the Azores."

To the list of forthcoming scientific books, given in last week's Nature, we are now able to add the following:—The Cotton Press announces:—"Synopsis of Diseases and

their Treatment," by Bornal, and "Notes Introductory to the Study of the Animal Alkaloids for Students," by Dr. A. M. Brown. Messrs. Sampson Low and Co., Ltd., promise:—"The Wild Flower Journal," by Mrs. Arthur Bell; "The Manufacture of Leather," by Charles T. Davis, new and revised edition, illustrated; "How to treat Accidents and Illnesses," by H. Morten, new edition, illustrated; "A Treatise on Paper-Making," by Carl Hofmann, new edition in parts, illustrated. Among Mr. Murray's announcements we notice:—"A Flower Hunter in Queensland," by Mrs. Rowan, illustrated. In Messrs. Nelson and Sons' list we find:—"Rambles among the Wild Flowers," by Dr. M. C. Cooke, illustrated. Mr. J. C. Nimmo announces:—"British Game Birds and Wild Fowl," by Dr. B. R. Morris, revised and brought up to date by W. B. Tegetmeier, 2 vols., illustrated. Messrs. George Philip and Son's announcements include:—"Life Size Anatomical Model of the Human Body, for Class Use"; "Model of a Locomotive Steam Engine, with an historical sketch and brief description of the working parts for the use of general readers and elementary students," by H. H. P. Powles; "Indian Frontier, a map of the North Western Frontier of India, with insets (1) showing the overland route to India, (2) a military map of the Indian Empire" (scale: 55 miles to 1 inch; size: 22 × 30 inches); "Klondike Gold Fields, a map of British Columbia showing the Klondike, Cariboo, Kootenay and other Gold Fields, with inset map of West Canada showing the route to the new Gold Fields" (scale: 47 miles to 1 inch; size: 22 × 30 inches); "Philips' Revolving Planisphere and Perpetual Calendar" (special edition for desk use); Messrs. G. P. Putnam's Sons give notice of:—"Religions of Primitive Peoples," by Dr. D. G. Brinton, and "The Liver of Dyspeptics," by Dr. Émile Boix. Messrs. Rivington and Co. promise:—Handbooks of Practical Science, in three books, to be published separately: No. 1, "Physical Measurements"; No. 2, "Chemical Experiments"; No. 3, "Experimental Mechanics," by G. H. Wyatt; and a New Edition of "Elementary Non-Metallic Chemistry," by S. R. Trotman. Messrs. Smith, Elder, and Co.'s list contains:—"Reference Book of Practical Therapeutics," by various authors, edited by Dr. F. P. Foster, 2 vols; "A Practical Treatise on Traumatic Separation of the Epiphyses, including the Anatomy of the Ephiphyses, the Pathological Anatomy, Symptoms, Treatment, and Results of Traumatic Separations"; "Spinal Caries," by Noble Smith, new edition, illustrated. The list of the University Correspondence College Press includes:—"A Manual of Psychology," by G. F. Stout; "The Tutorial Algebra," by W. Briggs, and Prof. G. H. Bryan, F.R.S.; Part i. Elementary Course; Part ii. Advanced Course; "Advanced Mechanics," by W. Briggs, and Prof. G. H. Bryan, F.R.S.; Part i. Dynamics, Science and Art; "Elementary Text-book of Mechanics," second edition, by W. Briggs, and Prof. G. H. Bryan, F.R.S.; "Properties of Matter," by E. Catchpool; "First Stage Magnetism and Electricity," by Dr. R. H. Jude; "An Elementary Text-book of Sound," by John Don; "The Tutorial Chemistry," by Dr. G. H. Bailey, Part ii. Metals.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, a Toque Monkey (*Macacus pileatus*) from Ceylon, a Sooty Mangabey (*Cercocebus fuliginosus*), a White-crowned Mangabey (*Cercocebus æthiops*) from West Africa, presented by Mr. W. S. Gilbert; a White-fronted Lemur (*Lemur albifrons*) from Madagascar, presented by Mr. George F. Gardner; a Rufous Rat Kangaroo (*Æpyprymnus rufescens*) from New South Wales, presented by Dr. J. S. Williams; a Greater Black-backed Gull (*Larus marinus*), four Lesser Black-backed Gulls (*Larus fuscus*), British, presented by Mr. W. J. Simpson Ladell; four Rollers (*Coracias garrulus*), twenty Marbled Ducks (*Marmaronetta angustirostris*), two Pochards (*Fuligula ferina*), six Black-bellied Sand Grouse (*Pterocles arenarius*), two Pintail Sand Grouse (*Pterocles alchata*), three Stone Curlews (*Ædicnemus*) *scolopax*), twelve Pratincoles (*Gareola pratincola*), nine Great Bustards (*Otis tarda*), four Little Bustards (*Otis tetrax*), two Slender Gulls (*Larus gelastes*) from Spain, two Serrated Terrapins (*Chrysemys scripta*) from North America, four Reeve's Terrapins (*Damonia reevesi*) from China, an Amboina Box Terrapin (*Cyclemmys amboinensis*) from the East Indies, a Bell's Cinixys (*Cinixys belliana*), two —— Sternotheres (*Sternothærus adansoni*) from West Africa, a Lesueur's Gecko (*Ædura lesueuri*), a White's Skink (*Egernia whitii*), two Cunningham's Skinks (*Egernia cunninghami*), two Lesueur's Skinks (*Lygosoma lesueuri*), a —— Skink (*Lygosoma mustelinum*), thirty-one —— Skinks (*Lygosoma decresiense*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

NEW DIVISIONS IN THE RINGS OF SATURN.—Prof. J. M. Schaeberle announces (*Astronomical Journal*, No. 411) that during the present opposition of Saturn he has detected a partial division in the B- or middle-ring of Saturn not previously seen by him. The new division is said to be 0″·7 from the inner edge of the B-ring, and the width about the same as that of the Cassini division. The fact that the new division is not conspicuous, like Cassini's, suggests to Prof. Schaeberle that the separation is not yet complete, and that the interval which he has detected contains matter which reflects light to such an extent that unless the conditions of seeing are very good it is indistinguishable from the general appearance of the B-ring. He has not been able to see the division between the middle-ring and the crape-ring, announced by Herr Brenner. Writing to the *Observatory*, Herr Brenner says:—"On August 27 I discovered two new divisions in the rings of Saturn; the one between the Manora division and the inner edge of the crape-ring is identical with the Struve division, discovered in 1850, and seen again in 1887 by Struvaert. The other division, between those of Encke and Cassini, is quite new, and was never before seen. Nevertheless it was more conspicuous than the Encke division and more extended too." In connection with these announcements it may be worth referring to a paper by Captain H. Kater, in the *Memoirs* of the Royal Astronomical Society (vol. iv. p. 383, 1831). Enough divisions in the outer ring are there described and figured to furnish astronomers with material for contemplation for some time to come.

A NEW METEOR PHOTOGRAPH.—We are glad that increased attention is being given to the photography of meteors. Prof. E. E. Barnard states (*Astronomical Journal*, No. 412) that he exposed photographic plates in two cameras on the mornings of August 10, 11 and 12, with the object of securing meteor trails. Only one meteor trail was secured, but this was a very fine one, the full length of the path, about 8°, being recorded upon the plates. The trail commences at R.A. 2h. 59m., Decl. + 23°·7, and ends in R.A. 2h. 59m., Decl. + 32°·0. The meteor must have been a very bright one, as the trail, which is perfectly straight, is strong and clear. Near the southern end of its path the meteor appears to have exploded, as there is a distinct enlargement of the trail at that point. The path continues a little beyond this in the same direction but fainter, and there is evidence of a second minor explosion about 1° from the first. It may be remembered that in the case of Mr. Butler's meteor photograph, reproduced in NATURE two years ago (vol. liii. p. 131) the meteor underwent a change of direction after it exploded.

Prof. Barnard has sent to the Royal Astronomical Society a copy of the photograph obtained with each camera.

THE ALLEGED FORMER REDNESS OF SIRIUS.—This subject is discussed at length by Dr. H. Samter in the September number of *Himmel und Erde*, and answered in the negative sense so far as human records are concerned. Besides some ambiguous references of Ptolemy and Aratus to the colour of the star, there is Horace's reference to *rubra canicula* or red dog-star, and Pliny's description of the colour as redder than Mars. But the

canicula may just as likely be Procyon, and the redness may have been due to its low altitude at the time of its first appearance in the sky after sunset. Hyginus and Germanicus Cæsar use the word *candidus*, that is, bright or shining white, in referring to the colour of the star. It is at least strange that Mars should have been so constantly, and Sirius so sparingly, referred to as red, and that not Sirius, but Alpha Scorpii should have been referred to as Anti-Mars (Antares). On the whole, Dr. Samter thinks the evidence is in favour of a very nearly white colour, as at present. The real explanation of the matter probably lies in the fact, pointed out some time ago in these columns, that the ancients observed Sirius at the heliacal rising, when it necessarily appeared red.

THE NEW GOVERNMENT LABORATORIES.

THE new Government Laboratory is built on a rectangular plot of land, 120 feet long by 65 feet wide, in Clement's Inn Passage, adjacent to King's College Hospital.

The exterior of the building is faced with red bricks with bands, corners and windows of Portland stone, and consists of four floors surrounded by an area whose retaining wall is faced with white glazed bricks. Central corridors run from end to end of the building on the basement and ground floors; a staircase at each end and a hydraulic lift give access to the various floors. The main entrance faces the gateway leading into Clement's Inn, and at the opposite end are two entrances for service purposes.

The architectural treatment of the first and second floors differs wholly from that of the ground-floor and basement: the entire central portion of the building forms one large room, 49 feet long by 43 feet wide, lighted by eight lofty mullioned windows and a flat-roofed dormer lantern, the open roof being carried on light iron principals. The floor of this room is about five feet above the ceiling level of the ground-floor rooms, and the space thus gained is utilised in raising the height of the principal rooms on the ground-floor, and as a duct, seven feet wide, below the floor of the central room, for holding the heating appliances, and water, gas and drainage pipes. The remainder of the building is divided into two sections by this room: each section consists of two floors with flat asphalted roofs, one roof carrying the water cisterns, and the other affording space for operations which it is desirable should be performed in the open air, a spiral iron staircase affording the necessary access.

The ground-floor corridor has a mosaic pavement, and with the exception of a few rooms in the basement, which, as well as the other corridors, are "granolithic," all the rooms have pitch-pine parqueterie flooring. The interior walls of all the laboratories, store rooms, and corridors, are faced with white glazed brick relieved by an ornamental dado of coloured glazed bricks; the only rooms with plastered walls being those intended for office purposes.

The basement floor contains a boiler house, engineer's workshop, store rooms, a mechanical laboratory, and laboratories for bacteriological work, water analysis, standardising scientific instruments, and verifying the hydrometers and saccharometers used in the Revenue Service. The mains for gas, water, and steam are carried along the corridor immediately below the ceiling, and are supported on light iron girders, every pipe being in view throughout its entire length. Underneath the corridor floor is the main ventilation shaft, a long chamber seven feet square, with which the several ventilating shafts and fume flues are connected. A powerful fan, worked by a silent one-horse engine, keeps up the air circulation and discharges the foul air into an upcast shaft surrounding the boiler furnace flue. A "return clean water main" also runs under this corridor floor, and after picking up branch mains from all the working laboratories, ends in a concrete tank of 7000 gallons capacity. Stores for house and steam coal, and a room for refrigerating machinery, have been constructed outside the main building, the former under the street pavement and the latter also partly in the area, which is here roofed in with Hayward's lights.

The main entrance leads into the ground floor, which contains on the left a waiting-room, the principal's private office, the reference library, and the research laboratory (a room 34 × 17 feet); on the right are the Crown contracts laboratories, a suite of three rooms having a total length of 69 feet by 17 feet, the private office of the deputy principal, and the reference sample laboratory, which is 28 feet long by 20 feet wide.

The chief feature of the first floor is the main laboratory, the central room already mentioned, adjoining which is a dark room for polarimetric work and a refrigerated room for storing samples. A short corridor leading to the main staircase gives access to two rooms for the superintending analysts and to the two tobacco laboratories.

The second floors contain photographic rooms, typewriter's office, museum, and four laboratories.

The building is lighted throughout by electricity obtained from the Strand Corporation, whose continuous 100-volt current is also employed for working various motors.

Rooms intended for offices have open fireplaces fitted with Teale's slow combustion stoves; the remaining rooms are heated by passing steam through iron radiators. In the main laboratory the radiators are below the floor in the central duct, and are connected with the external atmosphere by air channels covered with slate slabs, and the warm air enters the room through iron gratings which cover the duct. To prevent down draught a copper steam pipe runs all round the base of the dormer lantern; in all the other laboratories the radiators are on the slate slabs covering the air channels, usually in the centre of the room.

For ventilation, four large air shafts run from the upper corners of the main laboratory down to the basement, where they connect with the main shaft already mentioned, and in every room through which they pass there is an opening controlled by a "hit and miss" grating. The mouthpieces at the back of all the evaporation and draught closets are contained by downward flues into the same main shaft.

The water supply is from the New River Company's high-pressure main, branches from which run throughout the building direct to the various tables for working filter-pumps, turbines, and similar contrivances. For other purposes the water is stored in three cisterns on the roof, having a total capacity of 7000 gallons, from which it is distributed for boiler feed and ordinary laboratory work. To economise water, all the working tables are provided with special drainage outlets, which are connected by a system of iron pipes to the "return clean water main." The water discharged through this main into the concrete tank is pumped up into the service cisterns on the roof; the only water run to the drains is that used for cleansing purposes.

For ice making and refrigerating, one of Messrs. J. and E. Hall's carbonic anhydride refrigerating machines is employed, in which "brine" is cooled by the evaporation of liquid carbonic anhydride in copper coils surrounded by the brine, the cooled brine being used for making ice, cooling water, and for maintaining a low temperature in the sample store adjoining the main laboratory. This store is an insulated chamber with hollow walls, made of steel plates placed immediately in front of the insulation, through which the cooled brine circulates. The main laboratory has been specially designed for the evaluation of spirituous liquors, in connection with which a great desideratum is a supply of water fairly uniform in temperature all the year round. In the summer months the temperature of the ordinary water is lowered by passing it from the cisterns on the roof down to the refrigerating machine-room, where it runs through a cooler fitted with coils through which cold brine circulates. From the cooler the water is pumped by a centrifugal pump up to a special insulated cistern holding 1000 gallons, from which all the tables in the main laboratory are served.

The working tables have mahogany tops $1\frac{1}{2}$ inches thick, with fronts and ends of varnished Riga wainscot. In all rooms, except the main laboratory, the tables are placed against the outer walls immediately underneath the windows; they stand on a 3-inch plinth, which is protected by a recessed toe space and by making the table-top overhang 3 inches. They are uniformly 37 inches from floor to top of table, with a row of cupboards above the plinth topped by a single row of drawers. A space between the removable backs of the cupboards and the walls serves for carrying the water-pipes and draining troughs.

A white ware sink ($12 \times 9 \times 4\frac{1}{2}$ inches) is provided for each pair of workers, and behind it is a water standard fitted with Kelvin tap delivering into the sink, and side pipes with lever cocks

for condensed water. The outlet of the sink connects through a wooden pipe with a V-shaped wooden trough lined with lead and pitched, which, after picking up from all the sinks in the table, discharges into a galvanised iron funnel, also coated with pitch; a continuing pipe conveys the dirty water into drains outside the building.

Fischer's brass filter pumps with vacuum gauge attached are fixed to the tables, and the water passing through them is conveyed by a system of pipes into the clean water return-main, as is also the water drawn from the side tubes of the water standard.

Sets of shelves for reagent bottles, consisting of three plates of glass supported on gun-metal brackets, are fixed on the walls at the back or ends of the tables.

In the main laboratory there are eight tables arranged in two rows, four tables being on each side of a wide central gangway, with a clear space of five feet between each table.

The tops are twelve feet long by five wide, and each table affords working space for four operators: a white ware sink ($20 \times 9 \times 4\frac{1}{2}$ inches) is placed at each end of the table, and the standards delivering water into the sinks serve as pillars carrying a shelf nine feet long by one foot wide, which runs down the centre of the table between the two sinks at a height of one foot above the table top. Along the under surface the wires for the electric light are carried, and a plug is fixed on each side for motor attachments.

The two water standards are connected by a water pipe running underneath the shelf, and from this pipe four branches are taken on each side for supplying water to the still condensers. This water comes from the cooled water cistern, and after doing its work is passed through nozzles fixed on the table top into a pipe running underneath along the middle of the table, which finally connects with the return clean water main.

The tables stand on a plinth with recessed toe space, the top overhangs three inches all round; the cupboards and drawers are similar to those already described. Between the backs of the opposite cupboards is a space similar to that between the backs of the cupboards and the walls in the other laboratories, and this space is utilised for holding the water pipes and draining trough. The gas supply pipes are carried along the fronts of the tables in all the laboratories immediately below the overhanging portion, with off-takes leading to nozzles fixed on the top of the tables at the back. These off-takes are copper tubes which pass through the framing of the drawers, the contro. cocks being in front of the table.

All the principal laboratories are provided with evaporation closets, steam sand trays, steam drying ovens, distilled water apparatus, and cabinets for holding and using standard volumetric solutions.

The evaporation closets are very similar in character to those already in use at the Yorkshire College and elsewhere. They consist of a slate slab placed in front of a flue mouthpiece; a copper conical vessel is bolted to the under surface of the slab, which is perforated with a large bevelled hole in which is fitted a white stoneware collar. This collar, together with the copper portion, forms a hollow inverted cone, passing through the slate with a base 12 inches in diameter, on which is placed a thin steel plate coated on both sides with a rubber composition called "woodite," and perforated with holes of various sizes for holding basins, capsules and similar vessels. The upper portion is enclosed in a glass case resting on the slate slab, the front being a glass door sliding up and down by means of a counterbalancing weight working over pulleys. The roof is a plate of glass sloping down from front to back, with its back edge placed just above the top of the mouthpiece. A valve placed underneath the slab admits steam into the copper under portion of the cone, and any accumulation of condensed water flows away by a pipe fixed at a level slightly lower than the steam inlet. This pipe connects with a cubical cistern of brass with plate-glass front, arranged to act as a constant level apparatus in the event of steam not being available, in which case the bath is heated by a safety Bunsen burner placed immediately below the inverted copper apex.

The drying ovens, steam sand trays, and distilled water apparatus are all constructed as constituent parts of one appliance, through which steam from a single inlet circulates. The sand tray is a shallow copper vessel 30×12 inches; below it is a copper jacket lined with tin, through which the steam passes. It is well insulated and lagged round the sides and bottom, and forms the top of an enclosed oak cabinet fitted with wooden rails for holding dusters and towels, which are dried by the waste heat. Reduced steam first passes through a steam trap which automatically discharges the accumulation of condensed water, the outlet from the sand tray being so arranged that there is always available a supply of hot distilled water which can be drawn off as required through a Kelvin bib cock placed immediately over the cabinet doors.

From the sand tray the steam passes into the drying oven, which is fixed on the wall immediately above the sand tray. This oven is a stout copper-jacketed vessel insulated and lagged, the doors being fitted with plate-glass panels. Air for ventilation is admitted at the bottom and passes through a copper coil in the steam jacket, so that on entering the bath it is heated up to the temperature of the steam, and escapes through a similar opening at the top.

From the top of the oven a copper pipe leads the excess steam into the distilled water apparatus. This is an iron cylinder supported on brackets, and contains a block-tin worm, the upper end of which is connected with the pipe from the oven. The lower end delivers distilled water into a large earthenware jar standing on a wooden pedestal. A glass cock passes through a tubulure at the bottom of the jar in front, and through a similar tubulure on the right-hand side of the jar is fitted a glass water gauge, which also serves as an automatic overflow by being bent over into a funnel placed behind the jar; this funnel also receives water from the cylinder containing the block-tin worm, and by suitable connections delivers the water into the tank under the basement.

The appliance for holding the standard solutions is a shallow cabinet of Riga wainscot fixed against the walls, with polished plate-glass top and four doors; the panels of the upper doors are of glass, and the plinth is protected by a countersunk band of brass. The bottles containing the standard solutions stand on a shelf immediately behind the glass doors, and are fitted with two-holed rubber stoppers, through which pass a soda-lime guard tube, and a glass tube dipping down to the bottom of the bottle. This glass tube is connected, by india-rubber tubing which passes through a bevelled hole in the plate-glass top, with the stoppered side tube of a burette. Each burette is held in position by a pair of small clips fixed on two parallel brass bars, the bars being supported between a pair of brackets fixed to the ends of the cabinet on the plate-glass top. These clips ensure a perfectly rigid perpendicular position, and at the same time allow the burette to be easily raised or lowered. The burettes are filled with the standard solutions by suction through the top end of the burette, which is fitted with guard-tube continued by a depending piece of india-rubber to a glass mouthpiece.

The tobacco laboratory is provided also with special drying ovens and furnaces for incinerating vegetable substances. The drying ovens, three in number, are placed on the wall one above the other, and steam for heating them is generated in a special boiler standing close by, the condensed water flows back into the boiler, which is also connected with an independent water supply, having a valve and ball-cock for keeping constant level.

The carbonising and muffle furnaces are arranged in two chambers of white glazed bricks, supported on arches which spring from a large York flagstone; apertures in the roof communicating with a flue for carrying off the fumes and heated air. For carbonising the tobacco a special furnace has been designed. From the gas main in front of the chamber five branch pipes connect with long rectangular tubes. On each tube are screwed eight brass boxes, with a lever gas-cock between each box and the tube. Near each corner of the box a small Bunsen burner is fixed, and by this means a small flame plays uniformly over the under surface of the platinum dishes, which are supported on a light wrought-iron nickel-plated grid. The furnace is capable of holding forty dishes at one time. The front of the chamber, in which the furnace stands, is closed by a counterpoised glass door sliding up and down.

The incineration of the samples is completed in three muffle furnaces, of special design, heated by gas.

The whole of the work in connection with the building and fittings has been carried out under the immediate supervision of H.M. Office of Works, from designs supplied by Dr. Thorpe, and the manner in which the work has been executed reflects the highest credit on that department.

J. WOODWARD.

ZOOLOGY AT THE BRITISH ASSOCIATION.

BY arrangement between the Organising Committees, the presidents of the four biological sections gave their addresses at different hours, so as to make it possible for members to attend two or more. The address in Section D was given at 11.30 on Thursday, and followed Prof. Foster's address to the Physiological Section. After the address in Section D, some of the Reports of Committees were taken, and that of the Naples Zoological Station was most appropriately followed by a short statement, made by Dr. Anton Dohrn himself, as to the Naples Marine Station and its work. Dr. Dohrn dwelt chiefly upon his plans for the development of the station, how far they had been realised, and what still remained to be done. Prof. Ramsay Wright followed with a paper on a proposed lacustrine biological station, in which he gave a preliminary account of the microscopic fauna of the lakes of Ontario, pointed out the bearing of such observations upon problems of pisciculture, and the need of a biological station for the further study of the animals and plants in the great lakes. As a result of this paper, and of the discussion on the subject in Section D, towards the end of the meeting a deputation of biologists, consisting of Lord Lister, Prof. Ramsay Wright, Prof. Miall, Prof. Herdman, Prof. Poulton, Mr. Hoyle, Prof. Prince, and others, were received by the Hon. Mr. Hardie, Premier of Ontario, the Hon. Dr. Ross, Minister of Education, the Treasurer, and other members of the Cabinet, and spoke in favour of the establishment of a freshwater station by the Government on one of the numerous lakes in the Algonquin National Park. The proposal was very favourably received by the members of the Government present, and the Committee of Section D appointed a Committee, with a grant of 75*l.* for the purpose of assisting in the promotion of the scheme. It may confidently be expected then that as the result of this action in Section D a biological institution of both scientific and practical importance will be permanently established in the province of Ontario.

None of the other reports of committees call for special attention, and the only remaining paper taken on Thursday was Prof. Minot's on the origin of vertebrata. This gave rise to considerable discussion, in which Dr. Dohrn, Prof. Osborn, Dr. Gaskell, Prof. T. Gill, and others took part

Friday, August 20.—The Section opened at 10.30 with an interesting description by Prof. Osborn, of the restoration of *Phenacodus primævus* and of the skeletons and restorations of Tertiary mammalia in the American Museum of Natural History at New York. Prof. Osborn illustrated his remarks by a remarkably fine series of large photographs of the actual fossils and of their artistic restorations executed in water colours by Mr. Charles Knight. Prof. Osborn has had the famous skeleton of *Phenacodus*, originally described by Cope, entirely remounted, with the result that he finds it to be as digitigrade as the tapir, with the hind limbs more powerful than the fore, the tail of great size and the head extremely small. Prof. Herdman then gave an address upon oysters and the oyster question, illustrated by lantern slides, in which he dealt with oyster culture, the connection between oysters and disease, the presence of copper in some oysters, and the nature of the various kinds of greenness which occur in certain oysters. Prof. H. F. Osborn then gave a paper on the origin of mammalia, in which he discussed the evidence as to primitive lines of descent afforded by American Tertiary mammals. He showed that probably none of the forms up to now made known, ought to be regarded as the original stock of the mammalia. The rest of the papers taken on that forenoon dealt with detailed questions of fishes and fisheries, and were :—Prof. Prince's description of specimens of sea trout, capelin, and sturgeon from Hudson Bay, and the Esocidæ of Canada with description of a new species of pike found in Ontario, Dr. P. Cox's recent additions to the fish fauna of New Brunswick, and Dr. Carl Eigenmann's interesting exhibition of the blind fishes of America in a living state.

The Section opened in the afternoon with a paper by Prof. E. B. Poulton, illustrated by the lantern, upon "theories of mimicry as illustrated by African butterflies." He showed how various distinct forms with offensive characteristics and warning colours tend to converge in appearance, so as to share the responsibility of keeping up their character and spread the inevitable loss over a greater number. This was made known by Bates and F. Müller for South American forms, and by Moore for Indian, and now Poulton completes the case by evidence derived from African butterflies. There were two papers by Mr. A. Halkett, the one on *Branchipus stagnalis*, and the other on large specimens of Unionidæ from Lake Huron.

Two papers were given on the surface plankton of the Atlantic, one on this afternoon by Mr. W. Garstang, the other on Tuesday morning by Prof. Herdman. Mr. Garstang had collected his material on board the steamer *Laurentian* by tying a fine net over the bath tap and running the water through it occasionally during the day; Prof. Herdman had worked on the steamer *Parisian* by using four silk nets of different degrees of fineness over pipes through which the sea-water ran continuously day and night during the voyage from Liverpool to Quebec. These nets were emptied morning and evening. Mr. Garstang's method gave gatherings taken intermittently during the day, while Prof. Herdman's gave each day and each night as a continuous gathering. The results differed a little, showing that both these plans should be adopted in future observations. One point brought out by these papers was the efficient and inexpensive character of this method of collecting plankton. To obtain any number of samples of the surface organisms of the great oceans, collected either periodically or continuously, little or no expense need be incurred beyond the naturalist's passage. It is not even necessary that the naturalist should make the voyage himself. The methods of collection and preservation are so simple that they can be carried out by one of the officers on board. This method, which was first introduced by Dr. John Murray, will probably be largely employed by biologists in the future.

On Saturday the Section did not sit, as a natural history excursion had been arranged in conjunction with Section K.

Monday, August 23.—Prof. Poulton gave a paper on mimicry as evidence of the truth of natural selection, illustrated with the lantern. He described cases where very different butterflies and moths had converged in their characters, to a dark-coloured type of insect having certain clear spots upon the wings. These clear spots have been acquired independently in the different cases by entirely distinct methods—by loss of scales, by the conversion of scales into hairs, and in other ways. He also cited cases of various insects which mimicked ants, and which had acquired the resemblance by quite distinct methods.

Other papers taken this morning were :—Dr. L. O. Howard on economic entomology in America; Mr. J. F. Whiteaves on New Sepiadæ from the Lower Cretaceous of the South Saskatchewan; Prof. F. Y. Edgeworth on the statistics of bees: an inquiry into the time occupied by the successive journeys of workers; and by Prof. J. H. Panton on the appearance of the army-worm in Ontario during the summer of 1896.

In the afternoon Prof. Miall gave an account, with lantern illustrations, of a supposed new insect structure—a cellular organ found in connection with the heart and of doubtful function; Mr. W. Garstang had a paper on recapitulation in development, as illustrated by the life-history of the masked crab (*Corystes*); and Prof. G. Gilson gave a detailed description of the musculo-glandular cells in Annelids. Prof. Gilson's chief results are: (1) That the subepidermic part of the body-wall of *Polygordius*, *Owenia*, and many other Annelids consists of only one layer of mesodermic cells. These are much elongated and divide into an outer part, which becomes differentiated into muscular substance, and an inner one containing all the nuclei, and which has been erroneously regarded as cœlomic endothelium. The cœlom has no proper membrane on its parietal surface; and the myotomic sacs remain monodermic on their outer face. (2) That in *Owenia* the elements which constitute the monodermic outer wall of the cœlom, are musculo-glandular cells which may be classified with the neuromuscular cells of Cœlenterates. The author shows that the use of the secretion formed by the inner glandular processes of the cells is to produce a plasma in which the genital products float and are carried away.

The Section then adjourned to a natural history excursion at Ashbridge Bay, in conjunction with Section K.

Tuesday, August 24.—First came Prof. Herdman's paper "on the plankton collected continuously during a traverse of the Atlantic" (see above), and then a series of papers on vertebrate morphology; Prof. Theodore Gill on the determinants for the major classification of fish-like vertebrates, and on the derivation of the pectoral member in terrestrial vertebrates; Dr. W. H. Gaskell on the morphological significance of the comparative study of cardiac nerves, and Dr. Elliot Smith's observations upon the morphology of the cerebral commissures in the vertebrata.

The remaining papers before the Section were :—Prof. J. P. McMurrich on some points in the symmetry of Actinians; Prof. Lloyd Morgan on the natural history of instinct; Mr. W. G. McCallum on the hæmatozoon infections of birds; Mr. J. Stafford on the post-embryonic development of *Aspidogaster conchicola*, and Mr. G. P. Hughes on the antlers of the red deer, and on the evolution of the domestic races of cattle. Prof. Lloyd Morgan, in his paper on "instinct," replied to certain criticisms of the biological treatment of instinctive activities as relatively definite organic responses. Mr. Rutgers Marshall had argued that the "instinct of self-preservation," the "play instinct," and so forth, could not be regarded as in any sense definite. Prof. Morgan contended that these are group-terms under which a number of responses, each in itself relatively definite, are roughly classified. If we speak of "mimicking instincts" the group is so varied as to be quite indefinite as organic response. But when we study the particular cases which fall within the group, we find that each example shows an activity of a relatively definite kind.

The Section did not meet on Wednesday, as another natural history excursion was planned for that day in conjunction with Section K. It seemed desirable, to the biologists, on an occasion when the meeting was held out of Britain, that every opportunity should be taken of studying the more or less novel fauna and flora. This field work has been continued by some naturalists on the excursions which concluded the meeting. Thus Prof. Miall and Prof. Ramsay Wright have gone to examine the Algonquin Lakes; Prof. Herdman has been dredging and tow-netting in Puget Sound on the Pacific coast; while Profs. Bower and Marshall Ward have been collecting plants; and Prof. Poulton insects at many points along the line from Toronto to Vancouver.

PHYSICS AND CHEMISTRY IN RELATION TO MEDICINE.

THE advances of medical science due to the adoption of the methods and results of physics and chemistry have recently been generously acknowledged by several foremost members of the medical profession, in addresses delivered before congresses, and at the opening ceremonies of various medical schools on October 1. From the reports of a number of these addresses, the subjoined expressions of opinion have been collated. It is gratifying to be able to put on record these authoritative views as to the assistance which the physical sciences have given to medical progress.

Medical Progress due to Physical and Chemical Methods.[1]

All recent progress in medicine has depended on research and discovery carried on by physical and chemical methods. The mechanical principles that were first applied in anatomy, the mother science of medicine, to the explanation of the construction and movements of bones and muscles have been carried by the physiologist into every organ of the body and into the arcana of the tissues, and have been shown to be essential to the understanding of the changes that take place in them during the performance of their functions. And at the same time the aid of chemistry and electricity has been invoked to drive back step by step, and if possible to banish altogether, that vitalism which was at one time all but supreme in the domain of animal physiology. And now, not content with this corporeal conquests, the physiologist is pushing his mechanical methods into the realm of psychology, and is seeking by means of them to investigate the data of consciousness. Having by electrical stimulation and other experimental procedures localised sensory and motor centres in the brain, having shown that there is a definite order of development in the nerve tracts, and having disentangled to a large extent the paths of nervous impulses of various kinds, their halting points and goals in nerve cells, he is now eager to catch ideas on the wing and to examine them in the usual manner. Helmholtz, in his great works on vision and hearing, was the first to show how physics mount into physiology and psychology, and after him Weber, Fechner, Lotze, and Wundt have step by step pushed forward the parallels of the material accompaniments of thoughts and feelings. And quite recently a movement has sprung up in Germany to advance still further mechanical explanation of the facts of mental life, and to bring psychology, which has always been scientific in as far as it has observed and classified and analysed phenomena, into line with the exact sciences of external nature. Experimental psychology has been inaugurated, and research laboratories, in which the physical and vital changes that are associated with mental processes are to be measured and tested, have been established. Originating in Leipzig, experimental psychology has taken root in several other centres on the continent, has spread to America, where it has been eagerly adopted, and has at last made its way into England. The University of Cambridge has voted a sum of money to be devoted to investigations in connection with it, and a few months ago a meeting was held in London to promote the establishment of a laboratory for its study in University College. The names of those who attended that meeting are a sufficient guarantee that the project which it approved will be successfully carried out. I have little doubt that suitable arrangements will be made for instruction in the new methods of psycho-physical research in University College, and that in course of time other schools and colleges—Mason College amongst them—will follow its example and afford facilities for studies in anthropometric psychology. I have little doubt, too, that such studies will be fruitful of useful results, by widening the scientific basis of psychology and supplying us with standards by which to gauge the speed and duration of certain neural operations, the variations in these in different individuals, and the depth of certain mental defects. But at the same time I am disposed to think that exaggerated notions are entertained as to what experimental psychology can actually accomplish. Its field is, after all, a narrow one. It can never supplant self-observation and introspection as means of mental analysis, and must indeed always to a large extent lean on these. It is practically restricted to the measurement of sensations and movements and the gaps between them, or the simplest mental processes; and hitherto it has, it must be admitted, been somewhat ambiguous and indefinite in its declarations. For my own part I look with more sanguine expectations of light on the obscure problems of mind to comparative, ethnical, developmental, and pathological psychology—which may all, of course, be investigated by experimental methods—than to the new experimental psychology strictly so-called.

We all gratefully acknowledge the immense debt we owe to experimental physiology with its exact mechanical methods. It has dispelled myths and errors, supplied us with a body of precise and well-organised knowledge, and revolutionised our treatment of disease; and it promises in the future not only to augment our healing power, but to afford trustworthy guidance in education and in the regulation of some social relations. As it stands to-day physiology, it seems to me, offers a liberal culture to all who study it. An independent science itself, but in touch with all other sciences, it brings into exercise observation, judgment and memory, while it passes in review questions of surpassing interest to every human being, and thus confers an admirable intellectual discipline while storing the mind with information that must prove useful in the conduct of life.

Scientific Method in Medicine.[1]

Various spheres of activity have exercised their influences in bringing medical science to its present position.

We must, in the first place, ascribe the greatest importance to the study of anatomy. Gradually our knowledge of every detail of naked-eye anatomy has been gained, and at the present time every one practising medicine must have a competent knowledge on the subject gained by dissection. The same systematic study has extended to comparative anatomy, and great, for its time, as was the knowledge of Aristotle, it has undergone an entire revolution by the application of scientific methods to increased data of information by such workers as Cuvier, Darwin and Owen. It is now taught as a branch of medical education. Physiology could have no scientific basis until anatomy was fairly advanced. The facts on which it was at first based were founded on medical observations, but in the seventeenth century direct investigations and observations were commenced by Haller, Hunter, Spallanzani and Hewson. It has since been prosecuted with the greatest zeal and success, and the position of physiology

[1] Extracted from an address on "Ethics and Individualism in Medicine," delivered at the opening of the winter session of the Queen's Faculty of Medicine, at Mason College, Birmingham, on October 1, by Sir James Crichton-Browne, F.R.S.

[1] "The Influences that have determined the Progress of Medicine during the preceding Two and a half Centuries." Abridged from an address delivered at the opening of the Section of Medicine, at the annual meeting of the British Medical Association at Montreal, September 1897, by Dr. Stephen Mackenzie.

at the present time is that of a science, explaining the action and interaction of the organs and tissues, and the forces of the body, which is the true foundation of scientific medical knowledge—the Institutes of Medicine. The rise of physics and chemistry in the seventeenth and eighteenth centuries contributed greatly to the progress of medicine by increasing our powers of "searching out the secrets of nature" by methods and instruments of precision.

Of any one influence that has helped the advance of scientific study and the progress of medicine probably the increasing perfection of the microscope has been the greatest. With each new development of this instrument a greater range has been given to our researches, and with the assistance of chemistry it is continuing to reveal to us fresh facts that have created new branches of science.

Starting from the observations of Bichat on the minute anatomy of the tissues in 1801, the microscope has enabled us to understand the details of structure which were essential to complete anatomy. Until the microscope was capable of practical use the capillaries could not have been discovered by Malpighi, nor the composition of the blood understood; the mechanism of renal secretion could not be worked out until the minute structure of the kidney was known; the functions of glands, the process of digestion and secretion could not be understood until the histological details of the parts concerned were ascertained; the mechanism of light and hearing, of taste and smell were not revealed until the ultimate details of the structures involved had been investigated; the marvellous complexity of the nervous system, whether in the delicate though comparatively coarse structure of the nerves, the higher intricacy of the spinal cord, and the marvellous details of the arrangement of ganglionic cells and communicating fibres of the cerebral tissue, which by improved methods of preparation and staining are being revealed to us at the present time, could not have been worked out without its aid. Just as anatomy had to reach a certain stage before physiology and morbid anatomy became possible, so normal histology had to advance before pathological histology could come into existence; and as knowledge advances from the special to the general, special pathological histology had to reach to a very high point before we could reach that knowledge of general pathology on which our conceptions of the nature of disease are at present based.

The microscope again has introduced us to a new world, revealing minute organisms that play a great part in the plan of nature, and which are largely concerned in the production of disease. It has led to a new department of science, bacteriology, which has taught us how bacteria enter the body, how they increase and multiply therein, and how the tissue reacts for for self-protection. Chemistry has shown how the poisons formed by such organisms act in the body, and supplied us with means—as yet only in their infancy—for counteracting their effects or guarding against their exclusion and by protective inoculation. The microscope has further furnished us with evidence of parasitism other than bacteria in the blood, in the muscles, in the skin and hair, and on the mucous membranes. By its aid we are able to diagnose and watch the course of several primary diseases of the blood. It has enabled us to differentiate the various new growths that develop in our bodies. So much does the microscope constitute a necessary means of research that it would be impossible to perform our daily medical duties conscientiously without its aid.

The thermometer, again, has been of invaluable aid in the study of disease, allowing of our measuring and recording the degree of fever, and of watching its progress with such a degree of accuracy as to furnish us with evidence of the greatest value in the diagnosis, prognosis, and treatment of disease.

Electricity, by the laborious and complete investigations of Du Bois-Reymond, has revealed to us the mode of action of nerve and muscle that would have been impossible to obtain in any other way. Though the hopes at first entertained of its value in the treatment of disease have not been altogether fulfilled, it is still of much service in this respect, and perhaps still more valuable as an aid in diagnosis.

The ophthalmoscope, introduced by Helmholtz, has enabled us to understand diseases of the interior of the eye, which, without its assistance, was impossible. It has admitted of the exact examination of refraction, and has revealed changes in the termination of the optic nerve, in the retina and choroid, not only valuable in themselves, but so important in the light they throw on pathological changes occurring in the nervous system, and in the body generally, that the use of this instrument has become a necessity of practical medicine.

The laryngoscope perfected by Czermak has given a precision to the diagnosis and treatment of diseases of the throat not otherwise attainable, and which has important bearings on general medicine, by the recognition of paralyses of the muscles that move the vocal cords in aneurism and in disease of the central nervous system.

The sphygmograph, the cardiograph, the arteriometer, and, the latest invention of this class, the sphygmometer, have enabled us to ascertain the exact condition of the circulatory system, of the greatest service not only in studying the problems of normal and abnormal physiology, but in the recognition of disease and its tendencies, and in the influence of remedies.

All the branches of scientific knowledge we have been considering — anatomy and physiology, chemistry and physics, morbid anatomy and pathology, therapeutics and preventive medicine—have helped us to the knowledge we at present possess. But they have rendered a further aid to medicine than the mere knowledge they enabled us to acquire. Themselves scientific studies utilising methods and instruments of precision, they have influenced our whole mode of thought, and made us exact and precise in our observations and investigations of disease. We may paraphrase an expression of Burdon Sanderson's: "The history of modern medicine is largely the history of scientific method." So when we are taunted with the assertion that medicine is not a science, we can reply that medicine utilises the knowledge gained in every branch of science, and is scientific in its method of research into the nature and treatment of disease. If its results are not so exact as in some other branches of knowledge, this is not due to any want of scientific method and care in its investigations, but to the very complicated phenomena with which it has to deal, whilst the investigator has not the same unfettered freedom of dealing with his subject that the investigator into chemistry or physics has. By a continuance of the same methods and exact research, we cannot for a moment doubt that the progress that has been so manifest in the past will be exceeded in the future.

The Influence of Chemistry upon Medicinal Treatment.[1]

We must recognise that until the most recent times all remedies were borrowed from the purest empiricism. Unprejudiced physicians, armed with the weapons of scientific criticism, disentangled popular observations from superstitious and mystical ideas, and put to actual clinical test measures vaunted by their conservative colleagues, in order to ascertain whether in reality any use could be made of them. In consequence of the early state of scientific knowledge their judgment had necessarily to be based entirely on the results of practical experience without any experimental assistance. In this connection the history of digitalis is most instructive. Withering finds an old family recipe for dropsy; he does not keep to himself the results obtained with it, he finds the remedy of actual value, and in 1785 publishes it, with the results of his own cases, and so introduces it into practice.

It is extremely interesting that even the action of many of the chemical elements has been made use of in the form of the simplest house remedies. The ashes of the ordinary marine sponge have, for example, been much employed on account of their curative properties. When, however, chemical analysis found that they only contained soda, this valuable remedy, which had also found its way into medical practice, was for some decades laid aside. For in that period of chemical knowledge the mistake began of relying too much upon analytical results and of disregarding the strong evidence of clinical experience, because analysis did not necessarily detect powerful substances to explain the action of remedies. Owing, however, to the valuable discovery of Courtois, the soap-boiler, who separated iodine from the soda-lye of his factory, it was easy to demonstrate this element in sea sponges as well, and it had in consequence to be admitted that the results recorded with them were neither due to error nor to suggestion. And how noteworthy is it that in opotherapy also iodine was first discovered long after its value

[1] Abridged from an address on the Aims of Modern Medicinal Treatment, delivered at the Fifteenth Congress of Clinical Medicine at Berlin by Prof. Dr. Oscar Liebreich.

had been shown by therapeutic observations, made in ignorance of the fact that an iodine-containing organic body was present in the thyroid. Similar considerations apply equally to preparations of arsenic and mercury. It could not but happen that the philosophic point of view ascribed to all these remedies certain qualities which did not in reality reside in them. It is admitted, however, that the idea that as a matter of fact the chemical properties of a substance were of significance in regard to its action was known to Paracelsus. If, therefore, the fanaticism for this idea far overshot the mark, still the results then and afterwards obtained, and, indeed, the whole work of the iatrochemical school was not without therapeutic value.

The science of experimental pharmacology, which has arisen in our time, might well have contented itself with undertaking to put to the test the therapeutic material already to hand, and to contribute to the elucidation of its mode of action in order to be able to lay down more precisely the limits of its action, and so to lend a helping hand to clinical observation. It could easily have foregone the further empiricism of collecting new materials. But from the moment in which scientific remedies were brought into the domain of therapeutics, its horizon widened. It became necessary to take up and to seek to realise the idea of freeing the mind from empiricism, and of finding the leading principles by which the material of the healing art might be increased in a scientific manner. With the beginning of the attempt to establish this undertaking pharmacodynamics could no longer be satisfied to use merely the results of simple experiments upon living animals, but must needs also, with scrupulous attention to pathological principles, regard as its most important factor the representation of the conditions in health and disease as the basis of experimental inquiry.

In so far as concerns the search after new materials for remedies, one may correctly rely upon the principles of the iatrochemical school. Only those ideas must be excluded which, owing to deficient anatomical knowledge, rank as belonging to humoral pathology in the most rabid sense of the term. The investigators of those days stood also in the shadow of an alchemical environment, but had always before their eyes the endeavour to form an idea as to the nature of matter. For us, modern chemical ideas have created a new world. We know now that the smallest part of a chemical component—let us say, for example, a piece of sugar—is characterised by a special arrangement of the atoms of various elements, and that each change in their relative positions leads to the formation of a substance with new physical properties. The development of chemical research in this direction points to the discovery of innumerable new substances. One single reaction can yield several millions of these, and he who knows how to use the pencil aright can readily, by the construction of their formulæ on the paper, convince himself that the vast number of hitherto isolated organic substances forms but a minute part of those which can be assumed with safety to be capable of existence. This simple observation teaches us that we are no longer travelling along the route by which digitalis and the other old remedies of the healing art were made known to us.

It is very noteworthy that a long period elapsed before attention was paid to these powerful therapeutic adjuvants. It may be acknowledged with great thankfulness that this attention has been directed not only from the medical but also from the chemical side. In this connection, A. W. v. Hofmann correctly points out that after the discovery of so many organic substances some were soon brought into use for the sake of their external properties, while their internal applicability was never troubled about. Thus chloral hydrate was discovered in 1832, but its properties were first recognised through my pharmacodynamical researches in 1869. When new alkaloids were discovered, the task which lay before the chemist was to test their action upon the organism itself on the chance that it might fit in with a similarity in chemical constitution between their new substances and alkaloids. On account, however, of defective application of methods which lay out of their own beaten track, many chemists overlooked the true affinities of these bodies. In support of this may be adduced an example which has hitherto been scarcely ever quoted. Cocaine was discovered in Wöhler's laboratory. Its chemical similarity to atropine led to a chemical investigation of its topical action on the eye, and while it was noted that no dilatation of the pupil occurred, its remarkable property as a local anæsthetic was overlooked. Even the chemists found soon enough the exceptional loss of sensibility which cocaine causes when applied to the tongue; but it was Koller's medical observations and the clinical observations following which first indicated the correct position of cocaine as a drug.

The first ideas in testing the materials provided by chemistry in such enormous quantities must naturally be directed towards establishing a connection between their chemical constitution and their action. And from this line of thought many considerations naturally result. Before everything, it compels the speedy observation that the chemical division into groups such as alcohols, aldehydes, ketones, &c., has no bearing upon therapeutical action. Nevertheless, that a connection exists between the actions of certain chemical groups is not to be denied. It has been proved that the great group of bodies allied to antipyrin ("pyrazolones") exhibit similar therapeutic properties in a given direction. But we must always keep in mind that when we wish to speak of the connection between constitution and action, we must recognise that the effect of medicinal action upon the animal and human frame forms a complex whole, and cannot be mapped out with mathematical clearness. Bodies which lower the temperature produce an effect which is compounded of various different factors. The same is true of the lowering of blood pressure: thus one cannot scientifically represent that the chemical constitution of a given substance will be in relation to its influence on a complicated diseased condition such as migraine, or perhaps on the killing of the itch parasite, the destruction of which can be accomplished by the most varied toxic agencies. This imperfection of the new method must be admitted, but from its incompleteness no one can deduce that it is useless. On the contrary, its perfection promises to bring forward new and unexpected results.

But it must also be admitted that if the knowledge of the chemical material be made the basis of research and merely taken by way of comparison in relation to the remedies already guaranteed by experience, this alone already affords sufficient ground for rendering a portion of the chemicals available in treatment. In this connection I may recall, for example, the fact that working from the chemical constitution of cocaine bodies, such as eucaine were obtained which are not, it is true, identical in action with cocaine, but are able to replace it in many cases without exhibiting its toxic action. Thus in the search for new remedies it is no longer indicated that we should wait for chance results, as was formerly the case; we are, on the other hand, directed by scientific principles. Results crowned with success may be obtained through the most varied combinations which only those ignorant of the scientific method could describe as a "happy chance."

The Pursuit of Natural Knowledge.[1]

After referring to the history of University education in England, and congratulating Sheffield on the union of Firth College and the Medical School to form the new University College, and on its approaching admission as a constituent of the Victoria University, Dr. Pye-Smith said enough probably had been done for the present in constructing the framework for higher education in England. Accumulated endowments were still needful and the working out of the federal type of university. If he might offer advice drawn from the chequered and still uncertain fortunes in London he would say—trust to local wealth and public spirit and avoid Government grants as much as possible. Beware of the utilitarian spirit; let adequate provision, personal and material, be made first for literary and scientific research, secondly for education, and thirdly for technical instruction. The reversed order was the easier, but in the long run he ventured to think the less fruitful. While the moderating influence of statesmen and men of business and the interest and support of past students and graduates would find a valuable place in the constitution, let the chief responsibility rest upon those actually engaged in teaching and research.

Dr. Pye-Smith then went on to speak of the two senses of the word knowledge, both of them the objects of attainment by students of a university. The desire for knowledge how to do something is historically the earlier and is shared to some extent by the lower animals. Its end was: subjectively, the partly physical, partly intellectual pleasure of exercising the

[1] Abstract of part of an address delivered at the University College Sheffield, by Dr. Pye-Smith, F.R.S.

muscles and brain; objectively, the attainment of some useful object. Such knowledge was called skill or art, and the man who attained it was a skilled workman, an artisan, an artist, a master of his craft. The continuity of this kind of knowledge depended on tradition, and its improvement was by invention. Its acquirement was called technical education; its results were seen in the products of agriculture which feed us, in the ships and railroads which carry us round the globe, in the triumphs of steam and electricity, of preventive medicine and antiseptic surgery, in the matchless steel, the wondrous armour-plates, and all the vast output of the skilful industry of Sheffield. But there was another kind of knowledge—the desire for which came later in human history—the knowledge of what things mean, of how they consist, of why one event follows another. This knowledge was not active, but contemplative, not practical, but theoretical, not technical, but scientific. Its end was purely intellectual; subjectively, the pleasure of exerting the mental powers; objectively, the truth about things. We call this knowledge science; that is, not only acquaintance with the objects around us, or natural history (descriptive botany, zoology, mineralogy, geology, astronomy, and anatomy), but also some insight into their constitution and growth, into the laws of their origin, their actions, their decay and metamorphoses. This was called natural philosophy. Its improvement depended, not on invention of tools and methods, but on discovery of facts and their relations. It was only indirectly useful, and the pleasure it gave was in proportion to the intelligence of the man who felt it: "*Felix qui potuit rerum cognoscere causas.*" The abstract sciences seem to have arisen out of the needs of useful arts—geometry out of measuring the rising of the Nile, arithmetic out of counting the hosts of a Persian despot or the gains of an Indian money-lender, trigonometry out of setting landmarks, chemistry out of the alchemist's search after gold, botany out of materia medica, and anatomy out of surgery. Amply has the debt been repaid. At the present time all the progress in useful arts was called "scientific," and rightly so, for all depended upon natural science. Agriculture rested on the basis of organic chemistry, geology, and botany, navigation on astronomy, the working of metals on physics and chemistry, engineering on mathematics, medicine on physiology, and if ever the art of governing mankind was to be more than empirical, it would rest on profound knowledge of palæontology and neuro-physiology.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On October 1, the first day of the Michaelmas term, Dr. Alex Hill, Master of Downing, was formally admitted to the office of Vice-Chancellor. The retiring Vice-Chancellor delivered an address to the Senate, in which he reviewed the events of the past academical year. The emphatic rejection of the proposals in reference to degrees for women rendered it probable that some years must elapse before the University would grant any further rights or privileges to women students. The statement published last term by the Chancellor, as to the pressing financial needs of the University, had already led to one munificent gift of 2000*l.*, and it was hoped that this would be followed by others. Valuable donations to the museums and laboratories were acknowledged. Among new appointments were included the Professorship of Mental Philosophy, the Gilbey Lectureship in Agriculture, the Lectureship in the Hausa Language, and the Lectureship in Physiological Psychology.

The death of Prof. C. S. Roy, F.R.S., who has filled the chair of Pathology since 1884, took place on October 4. The late professor has been incapacitated by serious illness for over a year, but his death was somewhat sudden. The department has been superintended during his prolonged absence by Dr. Kanthack, of St. John's College, the deputy-professor.

IT is stated in *Science* that the plans are well formulated for the proposed new physical laboratory of Dartmouth College, New Hampshire, the result of the 75,000 dollars bequest of the late Mr. Charles T. Wilder. The committee has set apart 50,000 dollars for its erection and 20,000 dollars for maintenance. Additional grants have been made for an observatory, the foundations for which will be laid at once.

PROF. G. B. HOWES presided at the annual meeting for the distribution of the prizes gained by the students of the Westminster Hospital Medical School, on Thursday last. Reference was made in the report, read by the Dean of the College, to the resignation by Dr. Dupré of the post of lecturer on chemistry after thirty-three years' service, and it was stated that he had been succeeded by Dr. Wilson Hake. The entrance natural science scholarship, value 60*l.*, was awarded to Mr. E. C. Whitehead, and the entrance scholarship of 40*l.* to Mr. F. D. Martyn.

MR. R. C. CHRISTIE has given to Owens College, Manchester, the whole of his share of the estate of the late Sir Joseph Whitworth, as residuary legatee. It is estimated that the value of the gift is 50,000*l.* Mr. Christie has expressed the desire that the sum should be devoted to the erection of such buildings as the governors should think fit in connection with the college, only stipulating that the name of Sir Joseph Whitworth may be associated with the new buildings, and that they may be accepted and treated as a further gift from him to the college. It is also announced that two friends of the college have given sums respectively of 20,000*l.* for the erection of a physical laboratory and 5000*l.* for the maintenance of it; also that Mr. Edward Holt, of Manchester, has sent a cheque for 1500*l.* towards the erection of a museum at the college. Mr. Christie's fund will probably be devoted first of all to the erection of a hall for ceremonial and other large gatherings at the college.

MANY of the syllabuses of the subjects in which examinations are held by the Department of Science and Art have been modified. As already announced, the examinations in the honours stage of most of the science subjects will in future be divided into two grades: Part I. of a more advanced character than the advanced stage; and Part II. dealing with the highest branches of the subject. The honours portions of the syllabuses of most of the subjects have been re-written in consequence of this new regulation. The syllabuses of naval architecture, applied mechanics, and general biology (Section I.) have been entirely re-written. Prof. J. Perry is now an examiner with Mr. W. H. Greenwood in applied mechanics, and the new syllabus of the subject gives unmistakable evidence that he has had much to do with its composition. Prof. Perry has also been appointed an examiner in steam; and Dr. Fream has been appointed an examiner in agriculture. Prof. L. C. Miall's new syllabus of an introductory course of biology should be seen by all who are interested in the teaching of the subject.

THE new Directory of the Department of Science and Art has just been published. Many modifications have been made, both in the regulations for conducting science and art schools and classes, and in the syllabuses of the subjects recognised by the Department. We can only refer to a few of the changes. It is announced for the first time that recognition may be refused to any class which the Department considers to be unnecessary, or to compete unduly with a neighbouring school. This regulation will probably be the means of reducing the undesirable competition which often exists between science classes near one another. Schools may now be managed by a public company, provided that the articles of association specify 5 per cent. per annum as the maximum dividend. Counties and county boroughs which possess an organisation for the promotion of secondary education may elect to be responsible to the Department for the science and art instruction within its area. In such case grants will in general only be made to the managers of new schools and classes if they are acting in unison with the local authority.

A LARGE building, in which the art and technical schools of Leicester will be incorporated, was opened by the Bishop of London on Tuesday. The cost of the new buildings and site is just under 40,000*l.* The site extends to nearly three-quarters of an acre, and the main frontage is 220 feet, with an elevation of four stories. Two of the floors are devoted to technical instruction in hosiery and boot and shoe manufacture, with a full complement of all kinds of old and new machinery showing the development of the processes of manufacture, engineering, plumbing, dyeing, painting, &c. The two upper floors will be occupied by the school of arts. A portion of the roof of the building is flat, and on this a conservatory has been erected for studies of plant-life. At the opening ceremony Sir Thomas Wright, chairman of the committee, stated that the whole of the funds for the new building would be provided out of the excise

duties, or what was commonly called "beer money." This contribution from the Exchequer would be sufficient to pay the interest on the outlay, provide a sinking fund, and leave a balance of 1250*l*. per annum towards the annual expenditure.

IN an introductory address delivered at the Yorkshire College, Leeds, on Friday last, Mr. T. R. Jessop described the magnificent provision made for the study and practice of medicine and surgery in some of the cities in Russia. He said that he found several of the Russian hospitals and cliniques far in advance of our own. Of the recently completed Moscow cliniques it was difficult to speak in adequate terms. Built at a cost of about half a million pounds sterling, half of which was contributed by a few wealthy ladies, whilst the remainder, as well as an endowment of 43,000*l* yearly, was guaranteed jointly by the Imperial Government and the municipality, they consisted of a dozen or more separate detached handsome buildings, erected on an open estate of from forty to fifty acres, situated about a mile and a half outside the busy city. Each building was a complete hospital, with its own lecture room, laboratory, professor's room, &c., and in those requiring it there was provided a suite of operating rooms which might well serve as models for any hospital. Each building was adapted for a special purpose, for dealing, namely, with surgical or medical cases, children's diseases, ophthalmic, contagious, nervous, nasal, and aural affections, and so on. And all this had been done for the sole purpose of educating medical students, and providing the country with competent medical men.

THE following entrance scholarships have been awarded in medical schools :—*Guy's Hospital Medical School:* Scholarship for University students (anatomy and physiology), of the value of 50*l*., to Mr. A. H. Davies, Caius College, Cambridge. Open scholarships in science —First scholarship, of the value of 150*l*., to Mr. A. E. H. Parkes, Guy's Hospital Medical School; second scholarship, of the value of 60*l*., to Mr. W. H. Harwood-Yarred, Dulwich College. *St. Mary's Hospital Medical School:* Science scholarships.—144*l*., Mr. M. F. Kelly; 78*l*. 15*s*., Mr. J. B. Albury; 78*l*. 15*s*., Mr. D. E. Finlay; 52*l*. 10*s*., Mr. J. H. Wells; exhibition of 26*l*. 5*s*, Mr. H. R. Kidner and Mr. M. T. Williams. University Scholarships —57*l*. 15*s*., Mr. F. C. Eve; 57*l*. 15*s*., Mr. C. Killick; exhibition of 26*l*. 5*s*., Mr. A. Whitmore. *St. Thomas's Hospital Medical School:* First entrance scholarship in natural science (150*l*.) to Mr. W. H. Harwood-Yarred, and the second, of the value of 60*l*., to Mr. Francis H. Whitehead. The University Scholarship, of the value of 50*l*., to Mr. Frank Cecil Eve, of Emmanuel College, Cambridge. *Charing-cross Hospital Medical School:*—Livingstone Scholarship (100 guineas), to Mr. S. A. Boyd; Huxley Scholarship (55 guineas), to Mr. W. J. O'Brien; Universities' Scholarship (60 guineas), to Mr. W. G. Rogers. Entrance scholarships have also been awarded to Mr. E. Bayley (60 guineas), Mr. C. L. Lakin (40 guineas), and Mr. G. S. Welham (30 guineas). *London Hospital Medical College.*—Price Science Scholarship (120*l*.), Mr. J. Jones; Price Anatomy and Physiology Scholarship (60*l*.), open only to competitors from Oxford or Cambridge, Mr. C. Warren (Oxon.); science scholarship (60*l*.), Mr. R. T. Dolbey; science scholarship (35*l*.), Mr. M. T. Williams.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, September.—Climatological records for the British Empire in 1896. A table is given showing the chief climatological elements at eighteen stations in various parts of the globe, and is accompanied by interesting remarks upon the results. The highest shade temperature, 111°·2, occurred, as is most frequently the case, at Adelaide, in January. A temperature of 104°·8 was recorded at Malta, in August, which appears to be unprecedented. No station has ever approached Winnipeg in respect of minimum shade temperature, and the daily and yearly range, but the values for 1896 call for no special remark. The least daily and yearly range were recorded at Grenada; the values appear to be normal, and are very similar to those obtained at Barbados in former years. The highest mean temperature always occurs at Ceylon; in 1896 it was 81°·5, but the average for fifteen years at Bombay is less than a degree below that for Ceylon. The driest station, viz. that recording the lowest relative humidity, has for many years been Adelaide, while Esquimalt is the dampest. The highest temperature in the sun, 177°, was recorded at Trinidad, and the lowest temperature on grass was −23°·5 at Toronto; the radiation temperature is not registered at Winnipeg. The greatest rainfall, 101·06 inches, occurred at Colombo, and the least, 15·17 inches, at Adelaide, this value being much below the average. The fall at Mauritius, 68·17 inches, is the greatest since 1877. The greatest amount of cloud was recorded at Esquimalt, which slightly exceeds that of London; the clearest sky was observed at Grenada, where the average amount was 3·6, the scale being 0 to 10.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 27.—M. A. Chatin in the chair.—On the hypocycloid with three inflections, by M. Paul Serret. A continuation of a preceding paper.—On the stability of the phosphorescent sulphides of strontium, by M. J. R. Moureto. Specimens of phosphorescent strontium sulphide, prepared by five different methods, and exposed to air and sunlight at a temperature of 45° C., undergo a decomposition with production of hydrogen sulphide, and a sulphate.—On parastannyl chloride, by M. R. Engel. Metastannic acid, if washed with boiling water before drying in a vacuum, contains two molecules of water less than the acid prepared with cold water. This gives with hydrochloric acid an insoluble metastannic chloride, $Sn_5O_9Cl_2.2H_2O$, which differs from the chloride previously known by two molecules of water. From this a new stannic acid is obtained, to which the name of parastannic acid is given.—On some double chlorides formed by cinchonamine, by MM. Léon Boutroux and P. Genvresse. The alkaloid forms double chlorides with cadmium, zinc, and copper chlorides, the analyses and crystallographic characters of which are given.—On the improvement of humous earths, by M. J. Dumont. The application of potash manures, with a small proportion of lime salts, or of phosphatic slag, is recommended.

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THURSDAY, OCTOBER 14, 1897.

HINDU CASTES AND SECTS.

Hindu Castes and Sects: an Exposition of the Origin of the Hindu Caste System and the Bearing of the Sects towards each other and towards other Religious Systems. By Jogendra Nath Bhattacharya, M.A., D.L. Pp. xvii + 623. (Calcutta: Thacker, Spink, and Co., 1896.)

IN spite of all the books, essays and census reports dealing with the subject of Hindu castes, the problem of the origin of caste still remains one of the most difficult ethnological and sociological problems. We owe excellent treatises on the caste system as prevailing in certain parts of India at the present day to the industry of men like John Wilson ("Indian Caste," 1877), M. A. Sherring ("Hindu Tribes and Castes as Represented in Benares," 1872), D. C. J. Ibbetson ("Report on the Census of the Panjâb," 1881), E. J. Kitts ("Compendium of the Castes and Tribes found in India," 1885), J. C. Nesfield ("Brief View of the Caste System of the North-Western Provinces and Oudh," 1885), H. H. Risley ("The Tribes and Castes of Bengal," 1891-92), W. Crooke ("The Tribes and Castes of the North-Western Provinces and Oudh," 1896), and others. Eminent Sanskrit scholars, too, have devoted their attention to the caste system as represented to us in the most important works of Sanskrit literature, *e.g.* A. Weber ("Collectanea über die Castenverhältnisse," in his "Indische Studien," vol. x.), and J. Muir ("Original Sanskrit Texts," vol. i., 3rd ed., 1890).

A short time ago M. E. Senart published a most important treatise on the caste system ("Les castes dans l'Inde, les faits et le système," 1896). Proceeding from the modern system of castes, as described in the above-mentioned works, he tries to explain by it the old system of the four castes as found in the Vedic, epic, and legal literatures of ancient India. According to him, the so-called four castes of Sanskrit literature—Brāhmans, Kshatriyas, Vaisyas, and Sūdras—represent not four "castes," but four "classes," viz. the priests, the warriors, the Aryan people, and the non-Aryan slaves. But behind this system of four classes M. Senart discovers traces of a more complicated system, which he thinks was, on the whole, analogous to the modern Hindu system of numerous castes and sub-castes. Against this view of the caste system in ancient India, Prof. H. Oldenberg has quite recently (in the *Zeitschrift der deutschen morgenländischen Gesellschaft*, vol. li. p. 267 *seqq.*) raised serious objections. He shows that there is a natural development from the caste system, as found in the oldest Indian literature, to the theories of the Sanskrit law-books, and that the Buddhistic literature enables us —at least to some extent—to bridge over the gulf between the caste system of ancient India and its modern development. The caste system, as represented in the Pali literature of the Buddhists, has been fully treated by Dr. R. Fick ("Die soziale Gliederung im nordöstlichen Indien zu Buddha's Zeit. Mit besonderer Berücksichtigung der Kastenfrage," Kiel, 1897).

Even more divergent than the views about the historical development of the caste system, are the opinions of scholars regarding the origin of caste. While Mr. Risley considers it "scarcely a paradox to say that a man's social status varies in inverse ratio to the breadth of his nose," Mr. Nesfield asserts that "the question of caste is not one of race at all, but of culture," and Dr. Brockmann believes it to be proved that "the racial origin of all must have been similar, and that the foundation upon which the whole caste system in India is based, is that of function, and not upon any real or appreciable difference of blood."

With such a divergence of opinions, it is not difficult to prophesy that the caste problem is likely to occupy the attention of both Sanskrit scholars and ethnologists for some time to come, and Pandit Jogendra Nath Bhattacharya's book on the "Hindu Castes and Sects" may be welcomed as a solid contribution to the study of one of the most important problems in the history of India. This book has an additional value of its own, as coming from the pen of an intelligent and highly educated native, who at the same time is, if not an orthodox Brāhman, yet a proud member of the Brāhman caste. And it is of the greatest interest to see how such a native views the caste system and the development of sects—so intimately connected with that of castes—in his own country. Besides, a native has opportunities of getting information which it would be very difficult, and often impossible, for any European to obtain.

As to the origin of caste, Pandit Bhattacharya takes it for granted that the whole caste system is a creation of the Brāhmans and their Sāstras—a view of which few ethnologists will approve. Caste, like any other socia institution, must, after all, be a product of natural growth—though (just as is the case with other social institutions) fostered and turned to their own selfish ends by those who profited by it, in our case by the Brāhmans. Our author, indeed, as a staunch advocate of Brāhmanism, denies all such motives of selfishness on the part of the Brāhmans. "Caste," he says (p. 4 *seq.*),

> "has had its origin, no doubt, in Brāhmanical legislation. But there is no ground whatever for the doctrine that it is the outcome of the policy embodied in the Machiavelian maxim *Divide and Rule.* A very little reflection ought to show that the caste system, introduced and enforced by the Brāhmanical Shastras, could not possibly be the cause of any social split. On the contrary, it provided bonds of union between races and clans that had nothing in common before its introduction. . . ." He believes "that the legislation of the Rishis was calculated not only to bring about union between the isolated clans that lived in primitive India, but to render it possible to assimilate within each group the foreign hordes that were expected to pour into the country from time to time. . . . The authors of such legislation deserve certainly to be admired for their large-hearted statesmanship, instead of being censured for selfish ambition and narrowness."

Yet when we read of the extravagant prerogatives of the Brāhman caste, we cannot help admitting that the development, though not the origin, of the caste system is largely due to the ambition and selfishness of the Brāhmans. The position of the Brāhman in Hindu society could not be what it is according to the Sanskrit law-books and according to Pandit Bhattacharya's own description (p. 19 *seqq.*), if the Brāhmans had not used

every possible effort to inculcate the doctrine of their own superiority into the minds of the people.

"The more orthodox Sūdras," he tells us (p. 20), "carry their veneration for the priestly class to such an extent, that they will not cross the shadow of a Brāhman, and it is not unusual for them to be under a vow not to eat any food in the morning, before drinking Bipracharanāmrita, *i.e.* water in which the toe of a Brāhman has been dipped. On the other hand, the pride of the Brāhman is such that they do not bow to even the images of the gods worshipped in a Sūdra's house by Brāhman priests."

If a Sūdra be invited in the house of a Brāhman – that is to say, if he be invited to partake of the leavings of the Brāhman's plate—the Sūdra has to pay a "salutation fee of at least one rupee."

"But when a Brāhman eats in the house of a Sūdra on a ceremonial occasion, the payment of a fee by the host to the guest is a *sine qua non*" (p. 21).

Such customs, and the ideas underlying them, can only be understood by a long history of subjection—a subjection which was all the more thorough, as the ruling class was that of the priests, naturally the most powerful class in a country like India where religion was at all times the main force in the life of the nation.

Taking a bird's-eye view of the caste system, as sketched by Pandit Bhattacharya, we see before us a highly developed system of aristocracy. Here we have not only, as in most of the other countries, one class of society raised by hereditary rank above the rest of the people, but a graduated scale of ever so many distinct classes of society, every one of which claims superiority to the next lower class, the status of every family being determined by the traditions as to their hereditary rank, traditions which, in India, seem to be as trustworthy as a Gotha Almanac.

No man, as Pandit Bhattacharya shows, could pass himself off as a member of a Brāhman caste. The strict rules of etiquette require that every Hindu, when asked, must mention not only the names of his paternal and maternal ancestors, but give also information about his caste, his clan, his family or Gotra, his Pravara or ancestral family priests, his Veda, and the particular sacred books studied by his family. Our author tells us a characteristic story how a shoemaker was found out who wanted to pass as a Brāhman.

"With a view to have a share of the nice eatables provided for the Brāhman guests of a local Dives, he equipped himself like a Brāhman with his sacred thread, and quietly joined the company when they assembled in the evening. As usual on such occasions, one of the party asked him what his name and his father's name were. He said, in reply, that his own name was Ram Chatterjea and that his father's name was Kasi Lahiri. Being thus found out, he was hustled out of the place. His low position in caste saved him from kicks and blows, and while effecting his exit he gave expression to the sad moral of his adventure by muttering, 'a shoemaker cannot conceal his caste even under cover of night'" (p. 30).

Whatever may have been the origin of caste, whether race differences or differences of occupation, nowadays the social status of a man is determined neither by the breadth of his nose nor by his occupation, but by his genealogy. The very profession to the exercise of which the Brāhman owes his high social rank has fallen into contempt, for "according to Hindu notions, a priest is a very inferior person, and no Brāhman, who can live otherwise, would willingly perform the work of a priest" (p. 25). On the other hand, pedigrees are most highly valued. Take, for instance, the high class Rādhiyas or Kulins of Bengal, one of the most aristocratic of the Brāhman castes, who until recently were quite illiterate, yet—

"Their hereditary rank made them highly prized as bridegrooms for the daughters of their well-to-do clansmen, and many of them lived in former times by making marriage their sole profession. A Kulin of a high class might then marry more than a hundred wives without any difficulty, and there are still some who have such large numbers of wives as to necessitate their keeping regular registers for refreshing their memory about the names and residences of their spouses. Not only each marriage, but each visit by a Kulin to his wife brought him valuable presents, and as his wives and children were supported by his fathers-in-law, he could pass his days in comfort without being qualified for any kind of service or profession" (p. 41).

In spite of all the laws of the Sāstras prescribing certain occupations for each caste, there is hardly one profession that may not be exercised by any caste. We find Brāhmans employed as cooks (pp. 11, 22, 63, &c.), others who practise medicine (p. 48), many who live as agriculturists (pp. 50, 55, 131), and even as common servants (p. 131). The Valodras of Gujarat are partly money-lenders, and partly beggars who perform their begging tours on horseback (pp. 74, 81). Among the Audichyas in Gujarat there are also many professional beggars, and some who act as water-carriers (p. 75). The same variety of occupations is also found among other castes.

Pandit Bhattacharya divides the castes into six groups: 1) The Brāhmans, (2) the military castes, (3) the scientific castes (physicians and astrologers), (4) the writer castes (Kāyasthas), (5) the mercantile castes, and (6) artisan and agricultural castes, cowherds and shepherds, and domestic servants.

For every one of the numerous castes and sub-castes belonging to these six principal divisions, the Pandit gives us not only valuable statistics, but also highly interesting historical and ethnological data, which will be welcome to every student of the caste problem.

The second part of Pandit Bhattacharya's book is devoted to a survey of the Hindu sects. By way of an introduction the author states his views concerning the origin of sects and of religion in general. He defines religion as "the art of bringing men under priestly discipline," all religion being denounced by him as "the outcome of human policy," while founders of religious sects should be regarded like conquerors and political rulers. He uses very strong adjectives whenever he speaks of priests and founders of sects, but, strange to say, he never uses such strong language when he happens to speak of the Brāhmans. On the contrary, they are always spoken of as wise law-givers, whose "good and noble" teaching was corrupted by the sect-founders to whom such terms as "quacks" or "jugglers" are freely applied by the author.

The fact is, in speaking of the Hindu sects, Pandit

Bhattacharya is certainly not an unbiased judge, but a strong partisan of Brāhmanism. He denies that the sect-founders are religious reformers in any sense of the word.

"Looked at with the light of sober common-sense and unbiased judgment, the net result of their so-called reformations is that they let loose on society an army of able-bodied beggars, with the most preposterous claims on the charity and the reverence of the laity. Moral teaching of any kind very seldom forms a part of the programmes of our prophets. They teach their followers to sing some songs which tend either to corrupt their morality, or to make them indifferent to work for the production of wealth" (p. 359).

There is, no doubt, a great deal of truth in this criticism, but it is certainly not the whole truth about the religious systems of India. Our Pandit entirely fails to see the weak points of Brāhmanism which gave rise to the formation of the sectarian religions, and he utterly ignores the influence which the great philosophical systems of India exercised on the development of the sects. And altogether, he is too much of a partisan to be a good historian.

Nevertheless, there is a great deal of valuable information to be found also in this part of Pandit Bhattacharya's book. The numerous Hindu sects are grouped by him under the following classes:—(1) Siva-worshipping sects, (2) Sakti worshippers, (3) Vishnu-worshipping sects, (4) the disreputable Vishnu-worshipping and Guru-worshipping sects, (5) the modern religions intended to bring about union between the Hindus and the Mahomedans, (6) Buddhism, and (7) Jainism.

Not only in the chapter treating of the "disreputable sects," but also in the accounts of the Sivites, Sāktas, and Vishnuvites, much will be found that is of greater interest for the history of morality than for the history of religion. There is hardly one crime, however abominable, that is not recommended by one or the other of the so-called Hindu "religions," and the number of sects sanctioning sexual immorality is so large that we really need the assurance of our author "that the moral nature of the Hindus, as a nation, is, generally speaking, far superior to most of their religions" (p. 458). Although we cannot approve of Pandit Bhattacharya's wholesale condemnation of the Hindu sects, we have to admit that many of the latter-day prophets who founded "sects" during the last centuries fully deserve to be denounced as impostors. Take, for instance, Ram Saran, the founder of the Kartabhaja sect in Bengal:—

"To be ready with a pretext for exacting money from his followers, he declared that he was the proprietor of every human body, and that he was entitled to claim rent from every human being for allowing his soul to occupy his body. . . . To enforce his right and to give a pecuniary interest to his followers, the Karta appoints the chief men among the latter as his bailiffs and agents for collecting his revenue. The majority of the dupes of the sect are women, who readily pay the small tax that is demanded of them for the sake of securing long life to their husbands and children."

On the whole, I should like to recommend Pandit Bhattacharya's book rather to the scholar than to the general reader. At any rate, the latter will do well never to forget that the author is himself a member of one of the most aristocratic Brāhman castes. But the student of the history of civilisation in India will find in this book a great deal of useful and highly interesting information.

The value of the book is enhanced by an excellent index and glossary.

M. WINTERNITZ.

EXPERIMENTAL MORPHOLOGY.

Experimental Morphology. By Charles Benedict Davenport, Ph.D., Instructor in Zoology in Harvard University. Part First. *Effect of Chemical and Physical Agents upon Protoplasm.* Pp. xiv + 280. (London: Macmillan and Co., Ltd., 1897.)

THE term "experimental morphology" is new, and requires to be defined. We cannot do better than quote the author's own definition.

"Several distinct steps can be recognised in the progress which has been made in the interpretation of form. The earlier studies were concerned chiefly with answering the question, *What* are the differences between the various adult forms? The results of observations and reflections relating to this question constitute the sciences of descriptive and comparative anatomy. Next, a more fundamental inquiry was entered upon: *How* are these forms produced or developed? The results of observations and reflections upon this subject constitute the science of comparative embryology. Finally, in these later days a still more fundamental question has come to the front: *Why* does an organism develop as it does? What is that which directs the path of its differentiation? This is the problem which the new school of 'Entwicklungsmechanik' has set for itself—it is likewise the problem with which this book is concerned.

"The causes which determine the course of an organism's development are numerous, but fall into two general categories: namely, internal causes, which include the qualities of the developing protoplasm; and external causes, which include the chemical and physical properties of the environment in which the protoplasm is developing. . . . It is the purpose of the present work to consider the effects resulting from external causes.

"When we wish to isolate the separate effects in any complex of causes, we must resort to the well-known procedure of experimentation. . . . Accordingly we call in experiment to get an insight into the causes of organic form, and thus justify the name which we have applied to our study."

The author proposes to attack the problem of the influence of external agents upon organisms from four points, viz.: (1) their influence upon the phenomena exhibited by all living protoplasm; (2) their influence upon growth; (3) their influence upon cell division; and (4) their influence upon differentiation. The present volume deals with the first point only, and its scope will be best understood if we say that it treats of the *physiology of protoplasm*.

The book is mainly based upon the work of others, and owes not a little to Verworn. It is, in fact, the author's expressed aim "so to exhibit our present knowledge in the field of experimental morphology as to indicate the directions for further research." It is therefore

essentially a work of reference, and is rendered the more valuable in this respect by the addition of a fair bibliography appended to each chapter. The physiological character of the work will be at once recognised when the subjects treated of are enumerated. The action of chemical agents upon protoplasm is first dealt with, including the action of drugs and the relation between molecular composition and physiological action. The question of acclimatisation (immunisation) is considered both for inorganic and organic poisons. The author does not confine himself to the action of external agents upon single cells or unicellular organisms, but includes their action upon the whole organisation of individuals belonging to the higher vertebrates. Thus we find such experiments as those of Calmette upon immunisation to snake venom, and those of Nuttall and Thierfelder upon bacterium-free guinea-pigs, laid under contribution. The influence of oxygen upon the movements of bacteria and unicellular organisms, and the phenomena of chemotaxis in general occupy a special section of the chapter on chemical agents. The interesting observation of Roux, that isolated cells from the blastula of the frog move slowly in fluid, their movements being influenced by the presence of neighbouring cells, is referred to as a special morphologically interesting case of chemotaxis. The effect of adding or removing water to or from protoplasmic organisms: their vitality in circumstances producing desiccation, and the limits of such desiccation in the case of lower organisms, germs and seeds. The osmotic effects of solutions (with a very clear and interesting account of de Vries' fundamental experiments); this section includes also the acclimatisation of organisms to solutions of salt, *e.g.* of fresh-water organisms to sea-water, and *vice versâ*. The effects of mechanical disturbance—mechanical stimulation—upon amœboid movements, and upon direction of locomotion, including the effects of fluid currents (rheotaxis). The effect of gravity (geotaxis). That of electricity, and the differences displayed by different organisms in responding to galvanic currents, some, such as most Protozoa and Mollusca, responding to the positive pole (reacting at the anode on closure of the current)—anode-excitable or anex type—others, such as the Arthropoda and Vertebrata, responding to the negative pole (reacting at the kathode on closure of the current)—kathode-excitable or katex type. The phenomena of electrotaxis (positive and negative) in various organisms, the following general law being laid down for Metazoa: "Positively electrotactic organisms exhibit the katex type of irritability; and negatively electrotactic organisms exhibit the anex type, or, in general, the organism turns tail to the exciting pole." The action of light upon protoplasm, especial attention being given to the experiments of Engelmann with the microspectro-photometer, and those of Marshall Ward on the bactericidal action of the luminous rays. The phenomena of phototaxis and photopathy, including the effects of light in producing both bodily movements of organisms and movements of the protoplasm of cells, *e.g.* of pigment cells in the skin and retina. The effect of heat upon protoplasm, including the phenomena of rigor, both temporary and permanent, in muscle, with an interesting section on acclimatisation of organisms to extreme temperatures.

These are the subjects treated of, and it will be seen from the mere enumeration of them that the book covers a vast field of research: too vast to be really adequately dealt with within the modest limits of 280 octavo pages; nevertheless, it offers a valuable aid to the English student of biology. If we compare it with Verworn's well-known "Allgemeine Physiologie" (a better term, in our opinion, than experimental morphology—at least as applied to the subjects treated in this part of the work), which is a larger book covering the same ground, we find far fewer original experiments and observations, but a more complete account of the literature. Nevertheless, there are several noteworthy omissions. In dealing with the effects of chemical agents, the question of antagonism is untouched, and the important work of Ringer and others upon this subject is unnoticed. The same may be said for the work of Brunton, Cash, and others upon the relations between chemical constitution and physiological action. The chemical changes in protoplasm attendant upon its activity, and the effect of external agents upon such changes, are hardly so much as alluded to. The name of Romanes is nowhere mentioned, although his experiments upon the influence of chemical agents, of light, of gravity, and of electricity upon both animal and vegetable organisms are full of interest. But perhaps the most serious omission is the *relative lack* of allusion to the effects of external agents upon plant protoplasm In view of the light which may be thrown upon the phenomena exhibited by animal organisms by an account of those exhibited by plants under similar circumstances, it is in the highest degree desirable to bring the evidence derived from the two kingdoms together. For although, as the author puts it, protoplasm "must be a very dissimilar thing in different organisms," there must, nevertheless, be somewhere a fundamental identity between protoplasm from all sources. And, indeed, the author admits this:

> "It is with living *organisms* that we have to deal, and, accordingly, no distinction should be made between animals and plants. I have, indeed, made no such distinction; nevertheless, tastes and training have led me to lay especial stress upon animals. Even this is unfortunate, for the problem with which we are concerned is precisely the same problem in all *living organisms*."

We must, however, take the book as we find it, and although one could have wished it to be more developed in certain directions, it is still the most complete account in the English language of what may be termed (with Verworn) general physiology. This is a subject the study of which has increased so largely of late years, that there is hardly room for it to be more than merely touched upon in text-books of physiology; it has, in fact, grown into a self-contained branch of that science, with a more or less morphological bearing, and, as with the case of the morphology of the cell, is beginning to require a text-book to itself. We are glad to welcome Dr. Davenport's book as an attempt to furnish us with such a text-book in our own language.

OUR BOOK SHELF.

The Story of Germ Life. Bacteria. By H. W. Conn. From the Library of Useful Stories. (London: George Newnes, Ltd, 1897.)

THIS is a laborious and conscientious compilation of facts about bacteria, made ostensibly with the object of removing the slur said to have been cast upon these minute vegetables by an unsympathetic and unenlightened public. Had the writer been rather less ambitious in his desire to impart all the information he has collected, the story he tries to tell might have gained in the telling, and we should have had less of a record and more of a narrative concerning the habits and idiosyncrasies which prevail amongst the members of a microbial community. The tone adopted is often authoritative, and we should be glad to learn on what grounds Mr. Conn ventures to assert so positively that "preventive medicine will always remain unimportant."

The book claims thirty-four illustrations as an addition to the text, which are intended to represent various varieties of bacteria. Does Mr. Conn imagine because he is supposed to be talking to the uninitiated that his pictures of bacteria must be therefore correspondingly large, much in the same way as some people shout at foreigners, with the idea of making themselves more easily understood? As no information is given of the relation which exists between the size of the original object and the terrible travesties by which they are represented in the text, we much doubt if all the persuasive powers of the author will succeed in making the public regard his microbes in a friendly light.

Mr. Conn, however, has the merit of having conscientiously endeavoured to obtain accuracy in the manipulation of his material, a merit which is none too common in the popular treatment of scientific subjects, and the little volume bears throughout the impress of one who is an investigator and not only a writer.

G. C. FRANKLAND.

Natural Elementary Geography. By Jacques W. Redway. Pp. 144. (New York: American Book Co., 1897.)

THE illustrations are so numerous and attractive in this volume, that they make a picture-book of geography. The book has been constructed upon the plan recommended by the Committee of Fifteen appointed to consider the lines along which instruction in elementary science should be given (see NATURE, vol. liv. p. 310, 1896). The view of the Committee was that geography should be the study of the physical environment of man, and this conception has been borne in mind in the preparation of the volume before us. Beginning with familiar facts, the pupil is led naturally to knowledge beyond the range of his observation; generalisations never being made until the materials for their formation have been studied. He is encouraged to think for himself, by making much of the text interrogative, and providing material for the correlation and comparison of the characteristics of different districts; he is shown the value of map drawing and sand modelling in elementary geography, and relief maps give him good general ideas of the topography of the continents.

The pictures illustrate simple subjects, and will instruct as well as interest the young pupils who use the book.

As the book is an American production, it is largely devoted to the geography of the United States, less than two pages being given to the British Isles.

Kew Bulletin of Miscellaneous Information, 1896. (London: H.M. Stationery Office.)

THE Bulletins issued from the Royal Gardens, Kew, during 1896, are bound together with a very full index in the volume before us, the result being a valuable collection of miscellaneous botanical information. Many of the articles were referred to in our Notes when the Bulletins containing them appeared; nevertheless, attention may again be usefully directed to the articles on root diseases caused by parasitic fungi, natural sugar in tobacco, the new rubber industry in Lagos, sheep-bushes and salt-bushes, the cultivation of india-rubber in Assam, the botany of Formosa, German colonies in Tropical Africa and the Pacific, the Highland Coffee of Sierra Leone, and the flora of Tibet. The volume contains a review of the various aspects of the work of Kew since 1887, when the now familiar Kew Bulletin first made its appearance. We reprint this retrospect in another part of the present issue; and it furnishes the best of evidence of the active part which Kew plays in the development of our tropical possessions.

Wild Neighbours: Out-door Studies in the United States. By Ernest Ingersoll. Pp. viii + 301. Woodcuts. (New York and London: Macmillan and Co., 1897.)

THIS collection of articles from various magazines may be recommended to observers, and especially to young observers, of North American life. It contains a good deal of information, is written in an easy style, and bears frequent marks of personal familiarity with the animals described. A foreigner, visiting the United States for the first time, would pick up from this book, very rapidly and pleasantly, such knowledge of the commoner quadrupeds as he might extract from a well-informed naturalist, native to the country, in two or three weeks. The author has the habit of inquiry, and this renders his book particularly fit for young people, who may hope to fall in with grey squirrels, Canadian porcupines, skunks, racoons and wood-chucks. Perhaps the chapter on the "Badger and his kin" might leave the impression that shrews and moles are near relatives of the badger. "Animal training and animal intelligence" is a little bookish; and the performing elephants, &c., have little to do with the main subject. But these are trifles. The book is good of its kind.

L. C. M.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Edible Copepoda.

IT is no novelty to biologists that the Copepoda of the sea are edible; but it may interest some of your readers to hear that to-day, when passing through the Labrador current, in about long. 50° W., we caught, cooked, and ate a number of the large Copepoda which swarm there. It certainly seemed a new idea to the captain and some of the British Association passengers, who partook of the Copepoda stew, that it was possible to collect from an Atlantic liner going at full speed a sufficient quantity of these pelagic animals to make a respectable dish.

I may add that the collecting, on Dr. John Murray's plan, is as easy as the cooking. The sea-water is pumped into the ship, and is strained as it runs out through five silk nets of different degrees of fineness—four of them on overflow and taps running continuously day and night, the fifth in the bath worked intermittently for certain hours.

W. A. HERDMAN.

S.s. *Parisian*, September 29.

Brief Method of Dividing a Given Number by 9 or 11.

I SHALL be grateful if you will allow me to communicate, through your columns, to mathematicians generally, but specially to those engaged in teaching arithmetic, two new rules, which

effect such a saving of time and trouble that I think they ought to be regularly taught in schools.

Years ago I had discovered the curious fact that, if you put a "0" over the unit-digit of a given number, which happens to be a multiple of 9, and subtract all along, always putting the remainder over the next digit, the final subtraction gives remainder "0," and the upper line, omitting its final "0," is the "9-quotient" of the given number (*i.e.* the quotient produced by dividing it by 9).

Having discovered this, I was at once led, by analogy, to the discovery that, if you put a "0" *under* the unit-digit of a given number, which happens to be a multiple of 11, and proceed in the same way, you get an analogous result.

In each case I obtained the quotient of a division-sum by the shorter and simpler process of *subtraction*: but, as this result was only obtainable in the (comparatively rare) case of the given number being an exact multiple of 9, or of 11, the discovery seemed to be more curious than useful.

Lately, it occurred to me to examine cases where the given number was *not* an exact multiple. I found that, in these cases, the final subtraction yielded a number which was sometimes the actual remainder produced by division, and which always gave materials from which that remainder could be found. But, as it did not yield the quotient (or only by a very "bizarre" process, which was decidedly longer and harder than actual division), the discovery still seemed to be of no practical use.

But, quite lately, it occurred to me to try what would happen if, after discovering the remainder, I were to put it, instead of a "0," over or under the unit-digit, and then subtract as before. And I was charmed to find that the old result followed: the final subtraction yielded remainder "0," and the new line, omitting its unit-digit, was the required quotient.

Now there are shorter processes, for obtaining the 9-remainder or the 11-remainder of a given number, than my subtraction-rule (the process for finding the 11-remainder is another discovery of mine). Adopting these, I brought my rule to completion on September 28, 1897 (I record the exact date, as it is pleasant to be the discoverer of a new and, as I hope, a practically useful, truth).

(1) Rule for finding the quotient and remainder produced by dividing a given number by 9.

To find the 9-remainder, sum the digits: then sum the digits of the result: and so on, till you get a single digit. If this be less than 9, it is the required remainder: if it be 9, the required remainder is 0.

To find the 9-quotient, draw a line under the given number, and put its 9-remainder under its unit-digit: then subtract downwards, putting the remainder under the next digit, and so on. If the left-hand end-digit of the given number be less than 9, its subtraction ought to give remainder "0": if it be 9, it ought to give remainder "1," to be put in the lower line, and "1" to be carried, whose subtraction will give remainder "0." Now mark off the 9-remainder at the right-hand end of the lower line, and the rest of it will be the 9-quotient.

Examples. $\begin{array}{r} 9/\underline{75309\ 6} \\ 83677/3 \end{array}$, $\begin{array}{r} 9/\underline{\ 94613\ 8} \\ 105126/4 \end{array}$, $\begin{array}{r} 9/\underline{58317\ 3} \\ 64797/0 \end{array}$.

(2) Rule for finding the quotient and remainder produced by dividing a given number by 11.

To find the 11-remainder, begin at the unit-end, and sum the 1st, 3rd, &c., digits, and also the 2nd, 4th, &c., digits; and find the 11-remainder of the difference of these sums. If the former sum be the greater, the required remainder is the number so found: if the former sum be the lesser, it is the difference between this number and 11: if the sums be equal, it is "0."

To find the 11-quotient, draw a line under the given number, and put its 11-remainder under its unit-digit: then subtract, putting the remainder under the next digit, and so on. The final subtraction ought to give remainder "0." Now mark off the 11-remainder at the right-hand end of the lower line, and the rest of it will be the 11-quotient.

Examples. $\begin{array}{r} 11/\underline{73210\ 8} \\ 66555/3 \end{array}$, $\begin{array}{r} 11/\underline{85347\ 1} \\ 77588/3 \end{array}$, $\begin{array}{r} 11/\underline{59426\ 3} \\ 54023/10 \end{array}$, $\begin{array}{r} 11/\underline{47568\ 4} \\ 43244/0 \end{array}$.

These new rules have yet another advantage over the rule of actual division, viz. that the final subtraction supplies a *test* of the correctness of the result: if it does not give remainder "0," the sum has been done wrong: if it does, then either it has been done right, or there have been *two* mistakes—a rare event.

Mathematicians will not need to be told that rules, analogous to the above, will necessarily hold good for the divisors 99, 101, 999, 1001, &c. The only modification needed would be to mark off the given number in periods of 2 or more digits, and to treat each period in the same way as the above rules have treated single digits. Here, for example, is the whole of the working needed for dividing a given number of 17 digits by 999 and by 1001:—

$$\begin{array}{r} 999/754108364281 39\ 214 \\ 75486322750890/104 \end{array};$$

$$\begin{array}{r} 1001/\underline{754108364281 39\ 214} \\ 75335500927212/\ \ 2 \end{array}.$$

But such divisors are not in common use; and, for the purposes of school-teaching, it would not be worth while to go beyond the rules for division by 9 and by 11.

Ch. Ch., Oxford. CHARLES L. DODGSON.

Notes on Madagascar Insects.

HAVING recently received a small miscellaneous collection of rather typical Madagascar insects, collected by my son on that island, perhaps a modest, non-technical letter concerning them might interest your readers. The climate is so deadly to Europeans that insect-collecting is hazardous in the extreme, and I think not much is known of the insects. Some of the Orthoptera are highly curious, possessing antennæ five and six times the length of their bodies, so as to be able to detect danger afar. The Longicorn beetles appear very similar to ours, but the markings on their elytræ are brighter. The beetles generally are remarkable for the extreme brilliancy in colouring of their under surfaces and legs, while the upper surface is dull. I apprehend, therefore, they are *not* ground feeders. The dragon flies appear similar to some of ours, both in size, colouring, and shape. There is a lantern fly, or two, and a mole cricket, much resembling ours.

The spiders are *not* large, but as ugly and venomous-looking as nature knows how to make them. But, oh, the Centipedes! —gruesome-looking, plated, mailed, jointed, spiny-tailed, and, corneous horrors, half a foot long, with twenty legs (each side) their rapidity in travel must be great, while the large curved fangs, attached to the "business end," suggest the deadliest of grips. Had Milton ever seen one, "Paradise Lost" might have contained another horror.

I have had mounted with them a praying Mantis (also from the island), to somewhat neutralise their felonious aspect, though I fear the usual attitude of this most hypocritical of insects (with its extended fore limbs) indicates *anything* but prayer, or even reverence.

The brilliancy in colouring of Madagascar butterflies is not remarkable for a sub-tropical region. Many are like our fritillaries in aspect, while the clouded yellows appear identical. A few of the white butterflies are also like ours.

Rottingdean, Sussex. E. L. J. RIDSDALE.

Protective Colouring.

THE following instance of apparent consciousness of protective colouring in a young bird seems worth recording. On August 14, while walking in my orchard, which being on a steep slope is terraced with low stone walls, I put up a young Nightjar (*Caprimulgus europæus*) which flew straight to the top of one of the walls and flattened itself down on a broad flat stone. As it was within 6 feet of a hedge on one side, and there were gooseberry bushes, &c., on the other, there was no lack of cover if it had wished to hide. I left it there, and coming again two hours later found it in the same spot. Its colouring matched the stone on which it was lying so closely that had not one known that it was there, it would probably have been overlooked. On being closely approached it flew to another of the walls higher up, and crouched down in exactly the same way. I then tried to catch it with a butterfly net, when it flew over the hedge to a rough field on the opposite side of the valley from which it had, no doubt, come. ALFRED O. WALKER.

Nant-y-Glyn, Colwyn Bay, October 5.

THE MECHANISM OF THE FIRST SOUND OF THE HEART.

WHILST every one knows that the action of the heart is accompanied by sounds described as the first and second sounds of the heart, it is a remarkable fact that the mechanism by which the former of these phenomena is produced remains undetermined. It may be said to be almost universally accepted that the second sound is the result of the sudden tension of the semilunar valves, caused by the resistance which they offer to reflux of blood from the great vessels into the ventricles on the cessation of the systole. The difficulties which exist are connected with the first sound, and they result mainly from the fact that a number of events occur simultaneously with the systole of the ventricles and with the sound. Two of the most striking of these events, namely, the closure of the auriculo-ventricular valves and the muscular contraction of the walls, are regarded by many authorities as the source of the first sound. Sir Richard Quain in a paper recently read before the Royal Society has given a very graphic account of certain important investigations which lead him to the conclusion that neither of these explanations is correct, and which at the same time enable him to indicate what he believes to be the real explanation of the first sound of the heart.

In the first place, the author of this communication brings forward strong evidence to show that the action of the auriculo-ventricular valves is not the source of the first sound of the heart. This action consists in the simple apposition of the laminæ of these valves and the closure of the orifices by the musculi papillares and chordæ tendineæ, and affords no such tensive force as would suffice to produce the loud and characteristic sound which accompanies systole. More positive evidence is derived from the fact that the first sound can be heard independently of the existence and action of mitral and tricuspid valves in some of the lower animals, especially reptiles such as the python, which the author carefully auscultated in the Zoological Gardens, or when the valves are rudimentary, as in the kangaroo. The mitral murmurs familiar to physicians are, of course, formed at the mitral valve during systole; but they have no relation except in time with the first sound; they are merely accidental complications which occur at the moment of ventricular contraction, and the healthy first sound may be heard along with and independently of them.

In the second place, Sir Richard Quain shows that the muscular contraction of the walls of the heart during systole is not the source of the first sound of the heart. It is true that muscular contraction is accompanied by a sound, but this possesses neither the loudness nor the characteristic tone of the first cardiac sound. In opposition to the old experiments of Ludwig and Dogiel, which appear to show that after cutting off altogether the supply of blood from the cavities, one can still hear a systolic sound, the author puts the experiments of Prof. Holford, who made out that the sounds are heard or cease, respectively, according as blood is or is not admitted into the chambers. The classical observation of Stokes of Dublin that the first sound of the heart gradually disappears in the course of typhus fever, does not prove that muscular contraction causes the first sound, but that the impulse of the heart is so feeble that it is unable to produce the sound at the semilunar valves. The correctness of this view is confirmed by the fact recorded by Stokes, that the last point where the sound disappears in typhus is over these valves, whilst it is at the same point that it first returns. Further, Dr. Alexander Morison, working for Sir Richard Quain, found that in the bloodless heart of a recently killed turtle no sound could be heard during contraction sufficient to expel blood from the cavity. These facts and observations are, in the author's opinion, sufficient to prove that the contractile action of the muscles of the heart are not capable of producing the first sound.

After this destructive criticism, Sir Richard Quain proceeds to consider a third event which occurs during systole, namely, the propulsion of the blood contained in the ventricles into the pulmonary artery and aorta; and herein he finds the agency by which the sound in question is produced. He maintains that the first sound of the heart is caused by the impact of the blood driven by the action of the muscular walls of the ventricles against the block produced by the columns of blood in the pulmonary artery and aorta, which press upon the semilunar valves. Dr. Pettigrew has shown that the column of blood projected from the heart into the aorta (to take the left side only as illustration), is formed by the union of three columns with a spiral motion which is the result of the spiral arrangement of the musculi papillares and of the fibres of the walls of the ventricles, as well as of the spiral shape of the left ventricular cavity itself. By this rifle motion the blood is directed against the segments of the semilunar valves, which are hastily thrown apart, the spiral current being continued for some distance within the aorta. This beautiful rifle mechanism is constructed to give precision to the direction of the moving body against a given point, and to secure also velocity and force. In fact, we have here in nature the mechanism of the modern rifle. A resistance to the stream of blood from the ventricle is offered by the block formed by the column of blood resting on the aortic valves, wedged, and as it were screwed tightly, into each other. Whatever may be the absolute value of the propelling force of the left ventricle, authorities are agreed that the driving power and the resistance are to each other in the proportion of about four to three, the really important point being the relation they bear to each other. Now in this motion and in this resistance we have all the elements for the production of sound, inasmuch as sound is a phenomenon resulting from resisted motion. A sound being produced, we ask, What is it? and the reply must be: The first sound of the heart, the cause of which we seek. This explanation was first suggested to Sir Richard Quain's mind many years ago by a case of disease, in which the aortic valves were completely broken down and had become inadequate to their function. A murmur of such intensity was produced that it was audible three inches from the walls of the chest without a stethoscope. Over the femoral artery, however, there was no murmur, but a sound precisely resembling the first sound, caused by the motion of blood in the artery which received the full force of the ventricular contraction, the valves being destroyed. His attention was thereby directed to the natural obstruction offered by the aortic valves in health to the blood leaving the ventricle. Many observations have been made on the circulation in the femoral artery under like circumstances by continental physicians, but these have had reference to diagnosis only, not to the cause of the first sound of the heart in health.

An objection might be offered to this explanation of the first sound of the heart, that it is heard more distinctly at the apex of the organ, a point removed from the seat of the valves. The observation is correct, and the explanation of it is simple. The muscular walls of the heart are connected with the fibroid ring intimately associated with the semi-lunar valves. The sound produced at these valves is communicated to the apex of the heart through the fibroid ring and the muscular walls, which at the moment of systole are tense and firm. The sound thus conducted reaches that portion of the heart which is uncovered, and which is in contact with the walls of the chest. But, on the other hand, when opportunity offers, it has been found that the sound in question is heard over the aortic valves more distinctly than in any other

situation. A remarkable case of this kind has been related by M. Cruveilhier, who was invited to see an infant just born presenting a complete case of ectopia of the heart. He says: "On examining the heart thus exposed, both sounds were distinctly heard over the base, and *not* at the apex."

Lastly, the author has submitted the problem to the test of experiment, and finds that sounds resembling the first and second sounds of the heart can be produced artificially in accordance with his view. A sheep's heart is carefully prepared, and fitted with gutta-percha tubes for inlet and outlet, respectively, of water. If the ventricle be filled from the former, fitted into the left auricle, the water passes into the ventricle, and thence into the aorta, and finally rests upon and closes the aortic valves. If the ventricle be now compressed rhythmically in imitation of systole, and allowed to relax in imitation of diastole, a sound closely resembling the first sound of the heart is produced when the water is propelled from the ventricle into the tube fitted into the aorta; and another sound closely resembling the second sound of the heart is produced when the sigmoid valves close under the superincumbent weight of water in the aortic tube. As the fluid rises in the aortic tube, which is made three feet long, the pressure on the valves increases and the sound becomes more marked; when the fluid, on the other hand, diminishes, the sound becomes less distinct. The terminal piece of small diameter of a binaural stethoscope gently placed over the aorta at its commencement is most suitable for observing the cardiac sounds in this experiment.

It thus appears that the sounds of the heart are both produced at the same point—that is, at the semi-lunar valves; and each of them by its own single and simple agency.

Sir Richard Quain was moved to undertake and continue this inquiry by a desire to obtain a solution of what seemed to be an insoluble problem, and also by a belief that a correct explanation of the first sound of the heart would be of practical value in the study of the clinical phenomena of diseases of this organ. If the explanation given by him is so different from that hitherto accepted as to be calculated to create difficulties in the diagnosis of valvular diseases of the heart, closer consideration will show that this is not the case, but that, like all accurate knowledge, it simplifies and does not confuse. It affords an explanation of the relations of certain morbid phenomena which are at present unintelligible, such, for example, as that a systolic murmur may be heard at the apex, whilst the first sound is audible at the base free from murmur; and it will serve to encourage a closer study of the relation between muscular contraction of the walls of the heart and the tension of the vessels of the system.

THE DIVINING ROD.[1]

IT is certainly advisable to inquire into the foundation of all popular beliefs. In some cases popular feeling, or superstition—call it what you will—has undoubtedly led to the discovery of truths not at first understood or accepted by men of science. As, for instance, the danger in the proximity of the barberry-plant to crops of corn; a danger well known, though unexplained until the microscope was used to trace out the life-history of the minute organism which causes the mischief. On the other hand, careful and unprejudiced inquiry may prove the utter baselessness of some universally accepted belief. We have an instance of this in the statistical inquiry into the connection between the changes of the moon and of the weather. Such a connection is apparently taken for granted by every sailor and farmer; yet a careful analysis of the records shows that the belief is entirely groundless. We are inclined, therefore, to welcome a scientific investigation into the common use of the divining rod for the purpose of finding water or metallic ores.

Turning to the paper of 280 pages which forms the text of this article, we must confess to a feeling of considerable disappointment at the way in which the subject has been treated. What are the points at issue? And what should be the method adopted? Before entering into these questions it may be well to explain in a few words what is the "divining" or "dowsing" about which so much has been written. Here we can recommend Prof. Barrett's paper. He gives a lucid account of the process, clearly distinguishing between the instruments used, which he explains are evidently of no importance whatever, and the physical or mental state of the operator, which is the matter of real moment.

"Divining" or "dowsing" is a method of finding hidden springs or ores by the employment of persons supposed to possess a peculiar faculty not common to mankind in general. This faculty takes the form of a special sensitiveness which causes a forked hazel-twig, or other pointer, held in the hands, to point downward, or upward, when the operator is vertically over the thing sought for. The pointer is a mere "autoscope;" for one dowser used a watch-spring, another a German sausage, and others go with nothing in the hands. The twitching of the rod is, as Prof. Barrett points out, a mere indication of a muscular disturbance, not otherwise very obvious. In the search for water the usual method of divining is for the operator to walk across the ground, rod in hand, stopping at points where involuntary movements cause the rod to turn. At these spots he considers that water is to be found, and he will often go so far as to state the amount that a well sunk there will yield, and the depth at which the spring will be struck. We refer specially to the discovery of water; but the same method is used for the discovery of ores, and sometimes for the tracking of criminals, the feeling responding only, so it is said, to the presence of the particular object for which search is being made.

Two hundred pages of the paper before us are devoted to an "Examination of Evidence," or rather to records of the employment of diviners for the discovery of hidden springs. To this section we will now turn. It is obviously impossible within the limits of this article to analyse the mass of evidence. The difficulty of obtaining trustworthy information as to depth of wells, level of springs, yield of water and other circumstances is very great. Even where no personal feeling enters into the question, the details supplied need the most careful sifting. All we can here do is to take some one district, and see how far Prof. Barrett's records correspond with memoranda of our own, made in the course of a geological examination of the same area. Our notes were taken simply for the purpose of obtaining details of the strata, not to prove or disprove any theory.

Two wells are mentioned as sunk in the Isle of Wight under the advice of a diviner, both counting as successes. As to the first, at Arreton, we are only given the diviner's own uncorroborated account, and not knowing the exact site of his well it is impossible to form an opinion about it. At the other place mentioned, a house called Woodside, at Wootton, near Ryde, two wells had been sunk, under whose advice we know not, in the Oligocene clays, and, of course, they yielded no water. The diviner afterwards selected a site a few yards further south, on the edge of the sheet of plateau gravel which supplies water to all the farms and houses over its area. It did not need a diviner to give this advice; any cottager

[1] "On the So-called Divining Rod, or *Virgula Divina*: a scientific and historical research as to the existence and practical value of a peculiar human faculty, unrecognised by science, locally known as dowsing." By Prof. W. F. Barrett. (*Proc. Soc. Psychical Research*, part xxxii., vol. xiii. July, 1897.)

would have given the same, and water was obtained within seven feet of the surface.

These two successes are the only instances mentioned for the Isle of Wight. We, however, can give four others, all of which were failures. Happening to be at Wootton we came across three other wells being dug under the advice of the diviner—whether the same person as operated at Woodside we do not know. We watched the sinking with great interest, for they were all in strata which a geologist could not advise sinking into, and consequently could seldom examine. Each of the wells was abandoned long before the first water-bearing stratum was reached. In fact, an additional depth of fully two hundred feet would be needed to reach the first spring, and then the supply would be but small and the water bad. A fourth site selected by the diviner was in chalk close to the sea. Some months afterwards a geologist was consulted, and he had to advise that nothing but salt water could be obtained there. The fact that a diviner had previously been consulted was only made known to the geologist by an accident. Thus, instead of the Isle of Wight yielding two successes and no failures, it yields four failures, one success—one that did not need a diviner, and one which, on the diviner's testimony alone, counts as a complete success.

This brings us to the principal criticism that we have to make on Prof. Barrett's collection of facts—that he does not give enough weight to the natural tendency of mankind to conceal their failures. A man making a bet or speculation is inclined to boast of it if it is a success. But if it fails, he usually prefers to hold his tongue. It is much the same with divining. It is perfectly natural that both the diviner and his employer should wish to keep the failure secret.

Though the bulk of the paper is taken up with hearsay evidence, we are given two fairly satisfactory test cases, which should be noted by any one who, on the strength of the numerous reports, is inclined to employ a diviner. One of the cases we allude to is the careful trial made in the adits at Richmond Waterworks, in Surrey. Two diviners were employed independently to locate the springs; with the result that they did not agree, and that when borings were made at the spots indicated, most of them were failures. In another case, Prof. Barrett himself tested the powers of a diviner, who was said to have been highly successful elsewhere in finding both water and ores. In Prof. Barrett's hands he failed completely, though an expert thought-reader might have had fair success. The diviner in this case seems to have been accompanied by persons having a complete knowledge of the position of all the springs, wells, and pipes which the dowser failed to find.

If scientific men still think it worth while to spend time on this investigation, we would suggest certain precautions which must be taken before any results can be accepted. Hearsay evidence, like the bulk of that brought forward, is valueless. When the skill of the dowser is tested, it must be at a place where surface indications will not help. Before boring or sinking the dowser's report must be put into writing, and no additions to his prophecy should afterwards be accepted. The operator should not be accompanied by any one who knows the position of the springs or pipes which he is set to find. His companion should be a stranger who can note the exact spots chosen, and write down at the time the exact nature of the diviner's forecast. The depth to the spring, amount of water expected, and continuous or temporary yield should all be noted. It should be carefully recorded whether the diviner predicts an open fissure, which can be tapped by boring, or advises a sunk well to collect a percolating supply. This last precaution is a very necessary one, for it constantly happens that a small boring, with an area of perhaps ten square inches, misses a fissure, or penetrates it at a spot where the walls come together. On the other hand, a sunk well would have a superficial area of some 4000 square inches, and consequently have a far better chance of obtaining water.

One of the most satisfactory tests would be to set the diviner to map out in some clay district the intricate network of water-pipes and drains of an unknown town. Or, if he prefers still water, to hide a number of bottles, some full and some empty, under a cloth or board, and let the dowser select the full ones without touching or seeing any of them. After shifting the bottles a few times this ought to give a sufficiently large number of tests to enable the percentage of failures to be calculated. But here again there must be no one in the room who knows the position of the bottles.

In conclusion, we must express our opinion that this investigation, undertaken at the request of the Council of the Society for Psychical Research, leaves the question in the same state as it found it. We feel that the accumulation of second-hand evidence is of little use, and that what is wanted is a few careful tests by perfectly qualified and unbiassed observers. The Richmond inquiry was good, but the failure is explained away by the statement that the dowsers employed were not in the first rank, and were young and inexperienced. Unfortunately all the most successful prophets seem to be dead.

NOTES.

THE American Geographical Society has guaranteed Lieut. Peary the sum of 150,000 dollars to meet the expenses of his proposed Arctic expedition. Lieut. Peary has obtained five years' leave of absence, and will start upon his journey about the end of next July. The large meteorite he succeeded in obtaining during the expedition which returned to St. John's, Newfoundland, towards the end of last month, weighs over seventy tons, and is to be placed in the New York Museum of Natural History.

IT is announced that Prof. Sanarelli, director of the Montevideo Institute of Experimental Hygiene, who recently discovered the bacillus of yellow fever, has now succeeded in preparing a curative serum. The details of the discovery will shortly be published.

Science states that Prof. Michael Foster will deliver several lectures in Baltimore in the course of this month, and will visit Boston later to deliver a course of lectures at the Lowell Institute.

DR. FRANK CLOWES has been appointed chemist to the London County Council, in succession to Mr. W. J. Dibdin, who recently resigned the post.

THE Agricultural Committee of the University College of North Wales, Bangor, has acquired a large farm in Anglesey, near Llangefni, for the purpose of providing practical courses of instruction in agriculture, together with field experiments. It is noteworthy that the same site had been previously used for agricultural work, conducted under the auspices of the college long before the present proposal was contemplated.

AT the meeting of the London County Council on Tuesday, the following resolution was adopted :—"That it be referred to the Parks and Open Spaces Committee and to the Technical Education Board to consider and report upon the practicability of laying out plots of ground in certain parks in such manner as will afford assistance to scholars of elementary and secondary schools in the study of practical botany."

THE opening meeting of the new session of the Royal Photographic Society was held on Tuesday evening, the Earl of Crawford, president, being in the chair. The proceedings

commenced with the presentation of medals to the successful competitors in the Society's exhibition, the principal award being secured by Prof. Gabriel Lippmann (Paris) for specimens of colour photography by the interference method. The president afterwards delivered his annual address, the subject of which was "Weights and measures as they are used in photography." After suggesting what modification of present customs would best conduce to accuracy in result, facility of manipulation and computation, and increased volume of trade, he spoke of the origin and details of the metric system as applied to the science of photography, and contended that much might be done by the makers of photographic goods by giving metric dimensions to their cameras or plate-holders.

THE construction of the half-tide weir and lock across the river at Richmond has been so satisfactory in the results, and has added so much to the appearance of the river, that the inhabitants residing along he banks below this, and those interested in the boating, have for some time past been agitating for a similar weir and locks to be put across the river below Putney. The joint committee appointed by the several parishes in which this part of the river is situated have now obtained a report from an engineer advising that the site of the proposed weir should be situated about half a mile below Putney Bridge, and that the water should be held up to half-tide level. The width of the river at this point is nearly double that at Richmond, and consequently the cost of construction will be greater, the estimate being put at 250,000*l*. In a separate report made by another firm of engineers for the Wandsworth Vestry, the cost is put at 180,000*l*. It is stated that the proposed weir will not in any way interfere with the outfall of the drains and sewers which discharge into this part of the river, or clog the sub-soil drainage of the district.

THE annual "Fungus Foray" of the Essex Field Club will be held in Epping Forest on Saturday, October 16, under the botanical guidance of Dr. M. C. Cooke, Prof. Boulger, Mr. E. M. Holmes, Mr. G. Massée, and others. At the evening meeting at Warren Hill House, Loughton, Dr. Cooke will read a paper on "British Mycology during sixty years." Botanists wishing to attend should communicate with the hon. secretaries, Buckhurst Hill, Essex.

THE first meeting of the British Mycological Society was recently held at Worksop. On Tuesday, September 14, the woods on the Welbeck estate were explored, but little of note was found. In the evening Mr. George Massee delivered his presidential address on "Mycological progress during the past sixty years," after which he was unanimously re-elected president, and Mr. Carleton Rea hon. secretary and treasurer. During a visit to the demesne of Thoresby, an Entoloma, new to the British fungus flora, was discovered in Budby Wood, namely *E. hirtophyllum*. Other places in the district were explored, and some interesting specimens were obtained.

THE annual meeting of the Hull Scientific and Field Naturalists' Club was held on Wednesday evening, September 29; Dr. J. Hollingworth, the president, occupied the chair. The secretaries' report showed that great progress had been made during the year, and that the Club was in a very satisfactory condition. The reports for geology, botany, conchology, entomology, and ornithology testified that good work had been done during the year by the various sections. The botanists have been working out the flora of the East Riding, and have added a number of species to the Club's list of East Riding plants. The programme for the winter session 1897–98 includes lectures upon several very interesting scientific subjects.

A COMMITTEE, consisting of Sir F. Marindin (chairman), Earl Russell, Sir Douglas Galton, Sir C. Scotter, and Dr. J. S. Haldane, was appointed last February "to inquire into the existing system of ventilation of tunnels on the Metropolitan Railway, and report whether any, and, if so, what steps can be taken to add to its efficiency in the interest of the public." The report of the committee has just been issued in a Blue-book. That many portions of the Metropolitan Railway suffer from want of ventilation is well known. The committee draw attention to the amount of carbonic acid gas in the tunnel air, and to other impurities which arise from the emission of steam, and from the fuel consumed by the engines. After considering the suggested remedies of removing the impure air by fans placed midway between the stations, and the provision of additional openings, the creation of which were objected to by the local authorities on the grounds of public health and depreciation of property, the committee conclude by stating their conviction that pure air can be best obtained with certainty in these tunnels by means of electric working. In the words of the first of the conclusions of the committee, "By far the most satisfactory mode of ventilation of the Metropolitan tunnels would be by the adoption of electric traction."

PARTICULARS of the scientific work of the late Mr. William Archer, F.R.S., whose death we have already announced, are contributed to the October number of the *Irish Naturalist* by Dr. W. Frazer. Mr. Archer's special talent for patient investigations in connection with minute forms of vegetable and animal life was brought out by the Dublin Microscopical Club, which originated in 1849. In 1855 Mr. Archer prepared a list of Desmids obtained in Co. Dublin, illustrated with drawings, for the Zoological and Botanical Association of Trinity College, to which he afterwards added a supplemental list containing additional species. He edited for the second edition of Pritchard's work on Infusoria, the article "Desmidiaceæ," was the discoverer and describer of several new genera and families belonging to the Rhizopods, and published a special communication on *Ballia callitriche* in the *Transactions* of the Linnean Society. He was elected a member of the Royal Irish Academy in 1870, and subsequently served on its Council, and as Secretary for Foreign Correspondence from 1875 to 1880. In 1879 he was awarded the Cunningham Gold Medal. To the *Proceedings* of the Academy he contributed, in 1874, a paper on "Apothecia occurring in some Scytonematous and Sirosyphonaceous Algæ," and, in 1875, another on "*Chlamydomyxa labyrinthuloides*, a new species and genus of Freshwater Sarcodic Organism." In June 1875, he was elected Fellow of the Royal Society, and in the following year he was appointed librarian to the Royal Dublin Society. When a large portion of the library of this Society was afterwards transferred to form the present National Library of Ireland, he took charge of the new building, and only retired from his office in 1895.

THE piers which have been constructed by the Tyne Commissioners at the mouth of the river, entirely out of dues paid by vessels entering the Tyne, have provided a convenient and much-needed harbour of refuge for this exposed and dangerous part of the North Sea. These piers, which have only been completed about a year ago, after occupying forty years in construction, are causing very serious anxiety to the Commissioners, the North Pier having for some time past shown signs of giving way, and all attempts to stop the undermining of the wall by the waves having failed. In January last, during a very heavy north-east gale, the sea made a clean breach through the wall at about two-thirds from the shore. Acting on the advice of the eminent engineers called in to report on the matter, it has been decided that it will be necessary to take down about 750 feet of the outer end of the North Pier, and reconstruct it on foundations carried to a greater depth below low water to the hard rock; the estimated cost of this work being over 300,000*l*.

THE difference of temperature between stations in a valley and upon a hill is one of considerable importance to agriculturists, and has occasionally engaged the attention of observers both in this country and abroad. The Agricultural School at Scandicci, near Florence, has made comparative observations during the whole of the year 1895 at two stations, one being situated in a plain, and the other about 220 feet higher, on the side of a hill, both having a north aspect, and the thermometers sheltered from rain and terrestrial radiation. The detailed observations and generalisations are published in the *Bollettino Mensile* of the Italian Meteorological Society for August last. The results are very interesting, and show that in the plain the minimum temperature is generally lower, while the maximum is higher than that on the hill; in other words, the plain is colder during the night and warmer during the day. The mean annual temperature in the plain was nearly 3° below that on the hill.

EUCLID'S eleventh axiom has furnished material for discussion for many generations of mathematicians, and the latest contribution we have received in this direction is a series of short notes by Mr. Warren Holden, of Girard College, Philadelphia, beginning with a reprint from the *American Mathematical Monthly*, of an attempt to demonstrate the axiom, and including two separate proofs of the thirty-second proposition not involving the use of the term "parallel." Seeing that mathematicians have so fully investigated the geometry of non-Euclidian space, it need hardly be mentioned that Mr. Holden's proofs are based on alternative assumptions.

THE Stone Age of Phenicia has been elucidated by Prof. G. Zumoffen, and he has published his results in an illustrated paper in *l'Anthropologie* (viii., 1897, pp. 272, 426). Typical palæolithic implements have been found at seven stations. The forms known under the names of Chellian and Mousterian occur as well as other types. The Neolithic Age is characterised in Phenica, as everywhere else, by the presence of polished stone implements and coarse pottery. Four new stations have been discovered, in addition to the two found by Mr. Chester and described by Dawson in 1884.

THE decorative art of the Indians of the North Pacific Coast is the subject of a very instructive and well-illustrated paper by Dr. Franz Boas (*Bull. Am. Mus. Nat. Hist.*, New York, vol. ix. p. 123). The subjects are almost exclusively animals; each animal is characterised by certain symbols, and great latitude is allowed in the treatment of all features other than symbols. For example, the symbols of the beaver are large incisors, scaly tail, and a stick held in the fore-paws; of the hawk, a large curved beak, the point of which is turned backward so that it touches the face, &c. These symbols are often applied to human faces. It appears that the artist first tried to characterise the animals he intended to represent by emphasising their most prominent characteristics; these gradually became symbols, which were recognised even when not attached to the animal form. Dr. Boas very cleverly traces the distortions that result from the endeavour of the artist to adjust the animal to the decorative field in such a manner as to preserve as far as possible the whole animal and bring out its symbols most clearly, but without any idea of perspective. The representations are combinations of symbols of the various parts of the body of the animal, arranged in such a way that if possible the whole animal is brought into view. The arrangement, however, is so that the natural relation of the parts is preserved, being changed only by means of sections and distortions, but in such a manner that the natural contiguity of the parts is preserved. The success of the artist depends upon his cleverness in designing lines of dissection and methods of distortion. When he finds it impossible to represent the whole animal he confines himself to rearranging its most characteristic parts, always, of course, including its symbols. There is a tendency to exaggerate the size of the symbols at the expense of other parts of the subject.

PROF. PENCK publishes in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* an important contribution to the literature of the geology of the North-west Highlands of Scotland, from the standpoint of geomorphology. The author visited the region in question after the International Geographical Congress in 1895, and concentrated his attention chiefly on two points—the conditions under which the Torridonian sandstones were laid down, and the dynamical interpretation of the phenomena of the Ben More and Moine thrust-planes. The breccias lying immediately over the old gneiss are compared with formations observed by Dr. J. Walther in the peninsula of Sinai, and Prof. Penck suggests that the Torridon sandstones were laid down under climatic conditions similar to those now found in the latter region. From a minute discussion of the "experiments in mountain-building" of Cadell, Willis, and others, it is concluded that lateral thrust action only affects strata near the surface, but that in a typical case three different forms of displacement occur: simple sliding near the surface, a complex movement of sliding and dislocation below that, and a movement resembling the first in the lowest layers of all. These three stages in the formation of "fold"-mountain ranges are recognised as being at present exposed in the North German Plain, the Alps and Appalachian Mountains, particularly the Glarus Alps, and the north-west of Sutherlandshire, respectively.

THE idea that the many varieties of igneous rock found in a single district may have originated by differentiation from a single deep-seated rock-magma, is now familiar to geologists; but a more novel idea is suggested by Prof. Cole in a recent paper on "Slieve Gallion" (*Sci. Trans. Roy. Dublin Soc.*, vol. vi. part 9). He suggests that the fundamental earth-magmas may really be of extremely simple composition, and that the mineral complexity of plutonic rocks as we know them depends on the number of times an original magma has been remelted in a new environment, absorbing (or being absorbed) by substances of different composition. He is led to this conclusion by the phenomena of a granitic intrusion of Devonian age in the "Dalradian" schists of Slieve Gallion. The intrusive rock varies in composition from an aplite to a quartz-diorite, according to the surrounding material which it has partly absorbed as it intruded through it.

THE current number of the *Centralblatt für Bakteriologie*, Part ii., contains a paper by Messrs. Russell and Weinzirl on the rise and fall of bacteria in cheddar cheese. Determinations of the number of bacteria per gram in American cheddar cheese were made at different stages of the ripening process, whilst the varieties present were roughly classified under the heads of lactic acid bacteria, gas-producing bacteria, casein-digesting bacteria, and inert bacteria or those having apparently no effect on casein in milk cultures. In samples of green cheese examined immediately after it was removed from the press, a diminution in the numbers of bacteria present was noted as compared with the initial number present in the milk. This period of bacterial decline, however, generally lasts but two days, and is followed by a very marked increase in the numbers present later on, so much so that in the course of a few days, generally from eight to twenty, the germ contents may increase many-fold. This active bacterial growth is not by any means equally distributed amongst all the varieties of microbes present, but is almost exclusively confined to the lactic acid group of organisms, the gas-producing bacteria as well as the casein-dissolving varieties rapidly disappearing. The relation between this pronounced multiplication of the lactic acid bacteria and the ripening process in cheese is not yet exactly established, although the presumption is that

these organisms are mainly responsible for these changes. This presumption is rendered more likely by the fact that Freudenreich, studying Emmenthaler or Swiss cheese, found the same coincidence between ripening and multiplication of lactic acid bacteria, and Lloyd, in his investigations of English cheddar cheese, arrived at the same result and came to a similar conclusion. The maximum period of bacterial development is followed by a period of final decline; in the course of time cheese may become sterile, although an examination of a hard dry skim cheese over two years old exhibited the presence still of a few lactic acid bacteria.

THE Clarendon Press has issued an "Account of the Herbarium of the University of Oxford," prepared by Prof. Vines, from the collection made by Gregory of Reggio in 1606 down to the present time. The herbarium includes, among others, the very interesting collection of British plants made by Dillenius to illustrate the third edition of Ray's *Synopsis*.

THE early publication is announced of a monograph of the British species of *Potamogeton* or pondweed, by Mr. Alfred Fryer, an acknowledged authority on the genus. It will be brought out by Messrs. L. Reeve and Co. in fifteen monthly parts, royal 4to, each with four plates, coloured or uncoloured, by Mr. Robert Morgan.

THE *Journal de Physique* for September contains papers by M. R. Swyngedauw on the dynamical and statical explosion-potentials of a condenser; by M. L. Décombe, on multiple resonance; by M. Michel Petrovitch, on a graphic method of integrating certain differential equations; by M. A. Gouy, on a heating-stove of constant temperature; and by M. Potier, on asynchronous motors.

THE *Kew Bulletin* for October contains an interesting correspondence between the authorities of Kew and those of the colony of Sierra Leone, on the economical value for trade purposes of the oil of the "butter and tallow tree" of Sierra Leone, *Pentadesma butyracea*, belonging to the Guttiferæ. Its application to the manufacture of soap is suggested. In this number is also a plan of the Botanic Garden at Freetown, Sierra Leone.

IN connection with the *Revue Semestrelle des publications mathématiques* it is proposed to issue an index supplement to the last five volumes (1893–1897). The subject-matter will be tabulated under four different headings, namely, an index of journals, a subject-matter index, a biographical index, and a list of authors. As the *Revue* is issued by the Mathematical Society of Amsterdam with the view of providing a summary of current mathematical literature, the present volume should prove a useful work of reference to specialists.

A SERIES of chapters on "The Great Meteoric Shower of November," which have been published in *The Observatory* from the pen of Mr. W. F. Denning, of Bristol, have been reprinted by Messrs. Taylor and Francis, and form a pamphlet of fifty-two pages. The work is illustrated, and contains a large collection of interesting facts with reference to the great shower of Leonids, so it will be useful to intending observers of the brilliant displays expected during the ensuing few years.

THE latest number of the *American Naturalist* is the first which has appeared under the new editors. Dr. Robert P. Bigelow, of Boston, is now the responsible editor, and, following the system under which *Science*, the *Astrophysical Journal* and other American periodicals are conducted, he is assisted by an editorial board consisting of a large number of associate editors. The place which it is hoped the journal will take is between the strictly technical serial and the general scientific newspaper. "Every scientific man, as such" (writes the editor), "may well read two general scientific journals—the weekly scientific newspaper and the monthly review of scientific progress." The *American Naturalist* will aim at providing investigators with the latter form of scientific information. Authors of papers intended for beginners, such as "Some Birds of the Garden," "Some Common Weeds," are politely informed that their contributions are not wanted, and very technical works of interest to only a limited number of specialists will be declined. What the editors desire is scientific papers written by scientific people and of interest to scientific workers in more than one field. The desire is a praiseworthy one, and we hope the fulfilment of it will exceed the editors' expectations.

THE following are among the papers and other publications which have recently come under our notice:—"P. J. van Beneden, La vie et l'œuvre d'un zoologiste," by Dr. Ad. Kemna (Antwerp: J. E. Buschmann). This biography of a great investigator, with an analysis of his contributions to science, and their bearing upon the progress of natural knowledge, is a publication the like of which is not often met with in this country. The account covers 135 pages, and forms a tangible testimony to a life of service to science.—A geological map of part of Trail Creek mining division, West Kootenay District, British Columbia, has just been published by the Geological Survey of Canada.—Part vi. of Mr. Oswin Lee's work, "Among British Birds in their Nesting Haunts" (Edinburgh: David Douglas) has been published. The ten plates contained in this new part of Mr. Lee's attractive work illustrate nests of the heron, crossbill, kestrel, wheatear, whitethroat, and solan goose.—"On the Nature of the Röntgen Rays," by Sir G. G. Stokes, F.R.S. This—the first Wilde Lecture of the Manchester Literary and Philosophical Society—was delivered on July 2, and appears in the latest number of the Memoirs and Proceedings of the Society (vol. 41, part iv.).—"Recent Advances in the Science of Hygiene," an address delivered to the Haslemere and District Sanitary Aid Association, by the Hon. Rollo Russell (London: Economic Printing and Publishing Company).

A PAPER, by Prof. G. Linck, on the relations between the geometric constants of a crystal and the molecular weight of its substance (*Zeitschrift für Krystallographie*, vol. xxvi.) is summarised in the October number of the *American Journal of Science*. It is pointed out in the abstract that Prof. Linck has already called attention to the fact that the characteristics of crystals, that is, their geometric and optical constants, stand in direct relation to the atomic or molecular weight of the elements contained in them. This is most clearly shown in the eutropic series: a eutropic series being defined as a series of substances, crystallising similarly, but differing, only in that they each contain a different element, though the elements are yet similar according to the periodic system of Mendeléeff. If such a series is arranged according to increasing molecular or atomic weight, then the series, for all characteristics of the crystal, remains unchanged. The fundamental law of these phenomena the author has designated "Eutropy." For the present investigation it was necessary to know the system to which the crystal belonged, its axial relations, the specific gravity and the atomic weight. Tables computed from these data lead to the following conclusions: (1) The actual volumes of the various chemical compounds, if formed into equivalent crystals, stand in a very simple relation to each other. (2) The weights of these equivalent volumes stand in the same relations to each other as the molecular weights. (3) The volumes in a eutropic series increase with increasing molecular or atomic weights. (4) The weights of equivalent volumes always increase with increasing atomic weights. (5) Bodies which are isomorphous but not eutropic likewise stand in a very simple relation to each

other according to their crystal volume or their actual volume as the case may be. (6) Many crystals which have heretofore been considered eutropic or isomorphic are not so, since they probably possess a larger or smaller molecular weight according to the number of atoms.

THE additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mrs. A. H. Browne; a Crowned Duiker-Bok (*Cephalophus coronatus*, ♂) from West Africa, presented by Mr. A. Nightingale; a Nightjar (*Caprimulgus europæus*), British, presented by Mr. Richard Catter; Dusky Parrot (*Pionus fuscus*) from Guiana, presented by Mr. F. Scammell; a Scarlet Snake (*Cemophora coccinea*), an American Black Snake (*Zamenis constrictor*), two Testaceous Snakes (*Zamenis flagelliformis*), a Mexican Snake (*Coluber melanoleucus*), a Hog-nosed Snake (*Heterodon platyrhinos*), a King Snake (*Coronella getula*) from Florida, presented by Mr. J. H. Fleming; a Sœmmerring's Gazelle (*Gazella sæmmerringi*, ♂), a Striped Hyæna (*Hyæna striata*) from Egypt, deposited; a Golden Plover (*Charadrius pluvialis*), a Grey Plover (*Squatarola helvetica*), a Ringed Plover (*Ægialitis hiaticula*), a Bar-tailed Godwit (*Limosa lapponica*), British, an Eyra (*Felis eyra*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

CONJUNCTION OF VENUS AND JUPITER.—These rilliant planets may now be observed near together in the morning sky, and are rapidly approaching each other. Conjunction will occur on October 19 at 9h., when Venus will be only 0° 28′ N. of Jupiter, but they will be below our horizon. As a spectacle for the naked eye the varying positions of the two objects will be very interesting at about this period. Their times of rising and distances from each other on several mornings will be as follows:—

Date.		Venus rises.		Jupiter rises.		Approx. distance.		Sun rises.
		h. m.		h. m.		°		h. m.
Oct. 16	...	3 37 a.m.	...	3 59 a.m.	...	4	...	6 27
„ 17	...	3 40 „	...	3 56 „	...	3	...	6 28
„ 18	...	3 43 „	...	3 54 „	...	2	...	6 30
„ 19	...	3 46 „	..	3 51 „	...	1	...	6 31
„ 20	...	3 49 „	...	3 48 „	...	¾	...	6 32
„ 21	...	3 52 „	...	3 45 „	...	1½	...	6 34
„ 22	...	3 55 „	...	3 42 „	...	2¼	...	6 36
„ 23	...	3 58 „	...	3 40 „	...	3¼	...	6 38
„ 24	...	4 1 „	...	3 37 „	...	4¼	...	6 40

The star η Virginis (mag. 4·1) will be about 5° E. of the two planets on October 20. Venus will pass 0° 15′ N. of the star on October 23, while Jupiter will pass 0° 15′ S. of it on November 15. On the morning of October 24 the waning crescent of the moon will be about 7° S. of Venus, and a similar distance S.E. of Jupiter.

Conjunctions of Venus and Jupiter are not separated by a constant interval, but occur once at an interval of about 304 days, and then twice at intervals of about 443 days, as the following table of twelve conjunctions ending with that of October 29, 1899, will show. But this sequence is not invariable, for in the years 1861, 1862, and 1863 and 1882, 1883, and 1884, three successive conjunctions occurred at the interval of about 443 days.

Date of conjunction.		G.M.T.		Relative positions.		Interval in days.
		h.		° ′		
1888 January 2	...	4	...	♀ 1 51 N.	...	—
1888 November 1	...	9	...	1 31 S.	...	304
1890 January 18	...	21	...	0 26 S.	...	443
1891 April 7	...	9	...	0 13 N.	...	444
1892 February 5	...	22	...	0 1 S.	...	304
1893 April 28	...	17	...	0 4 N.	...	448
1894 July 19	...	20	...	0 51 S.	...	448
1895 May 18	...	4	...	2 5 N.	...	303
1896 August 2	...	11	...	0 40 N.	...	442
1897 October 19	...	9	...	0 28 N.	...	443
1898 August 19	...	6	...	1 51 S.	...	304
1899 October 29	...	13	...	♀ 0 33 S.	...	436

On October 21 next, at about 6.45 a.m. the relic of the great red spot, if still visible, will be presented nearly on the central meridian of Jupiter, and if the weather is clear, an excellent opportunity will thus be offered for securing an early observation of this remarkable feature

THE LEVEL OF SUNSPOTS.—Prof. H. Riccò brings together some statistics in reply to the recent discussions relating to the question of "Are sunspots cavities or not?" (*Astrophysical Journal* for August). The observations discussed were derived from a series of drawings of sunspots made by the method of projection in the years 1880 to 1890 at Palermo with a refractor of 0·25m. aperture, and at Catania with a refractor of 0·33m. aperture. The projected image was in all cases 0·57m., a size sufficient to satisfactorily show the principal details of the spots. The result of the discussion, as will be seen from the following figures, shows that the number of spots near the limb, whose projected form gave a result conforming to the theory of Wilson, greatly exceeds the number of contrary or uncertain cases. The facts show that from the years 1881 to 1892 the proportion of cases favourable, unfavourable, and neutral, were in the proportion of 7·3 to 1 to 2. If greater weight be given, as Prof. Riccò says, to spots near the sun's limb, the penumbra of which conforming to the appearance of a cavity seen in perspective is invisible on the side opposite the limb, "I have found twenty-three cases of this sort in the eleven years, and only one contradictory case." Prof. Riccò acknowledges the importance of the problem of the constitution of sunspots and the difficulties involved, and advocates Mr. Evershed's suggestion that the radiations of sunspots should be studied in a more complete manner.

THE ORBIT OF COMET 1822 IV.—On July 13, 1822, Pons, at Marlia, near Lucca, in Italy, discovered a comet which, two months later, reached its maximum brightness, developing about this time a stellar nucleus of the ninth or tenth magnitude. The observations extended over a period of several weeks, and the most satisfactory elements computed were obtained from the investigation carried out by Encke. A new and interesting computation of the elements of this comet has been undertaken by Dr. A. Stichtenoth (*Untersuchung über die Bahn des Cometen* 1822 IV., Leipzig, 1897, W. Engelmann) in his Doctor's dissertation presented before the Göttingen faculty. These new elements, which are not found to differ very much from those obtained by Encke, depend on 456 observations, which for the most part have been reduced directly from the original observations. Referred to the ecliptic they are as follows:—

$$T = 1822 \text{ October } 23\cdot772734, \text{ Paris M.T.}$$
$$\text{Log } q = 0\cdot0588426$$
$$\left.\begin{array}{lcl} \Omega & = & 92°\ 44'\ 23''\cdot01 \\ i & = & 127\ 20\ 47\cdot95 \\ \omega & = & 181\ \ 4\ 38\cdot08 \end{array}\right\} 1822\cdot0.$$
$$e = 0\cdot9963021$$

The investigation tells us that the period of revolution corresponding to the above value of the eccentricity, namely 0·9963021, amounts to 5449·0 years; but on account of the length of the elliptical orbit, this value of the eccentricity can be varied considerably without in any way interfering with the calculated positions: thus the period of revolution may be said to lie between 4504 and 8748 years.

A point of additional importance and of considerable interest which this new discussion of the observations discloses, is that an examination of the original manuscripts of Gambart and Olbers shows that the appearance of this comet was somewhat analogous to that of Comet Holmes. Gambart observed, namely on 1822 July 26, a sudden brightening of a stellar-like condensation in the nucleus, which at the beginning of August had completely disappeared. On September 20 and 21 Olbers observed a similar increase in brightness, but the decrease took place more slowly than in the previous case. It appears, therefore, that sudden variations in the brightness of the cometary matter which occurred in this comet were similar to those which were recently noticed (1893 January 16) in Comet Holmes, and can be easily explained on the meteoritic hypothesis.

The above interesting fact, connected with this nearly forgotten comet, adds an extra feature to this most thorough and complete "Arbeit," and Dr. Stichtenoth is to be congratulated on bringing his computation to such a successful issue.

THE LATE ALVAN G. CLARK.—Prof. Hale gives a brief obituary notice of the late world-renowned optician, Mr. Alvan Clark (*Astrophysical Journal* for August), which is accompanied by an excellent illustration showing him at the Yerkes Observatory with the crown lens of the 40-inch. In this notice Prof. Hale remarks: "It was no small proof of devotion to his work and interest in its successful termination that he should be willing to leave his home after a nearly fatal stroke of apoplexy, and to undertake a journey of over a thousand miles in order to accompany the 40-inch objective to its destination." We gather, also, that Mr. Clark considered the question of the possibility of constructing an objective still larger than his last great masterpiece, and, although fearing the effect of flexure, he considered it might be possible to still further increase the aperture without endangering the performance of the objective. Mr. Carl Lundin, who has been in the firm for five-and-twenty years, will continue to carry on the business.

A PLEA FOR A BUREAU OF ETHNOLOGY FOR THE BRITISH EMPIRE.

AT the meeting of the British Association at Liverpool last year, Mr. C. H. Read, of the British Museum, read a paper before the Anthropological Section, which deserves more notice than has been accorded to it. He urged that "what is needed in this country, with its vast colonial possessions, is a Bureau of Ethnology, such as has now existed for some time in the United States. The value of such an institution for our empire can scarcely be estimated. That its tabulated researches would be of the greatest importance to science will not be doubted; but its strongest claim to existence as a national institution is the immense service it would render, first, to the officers governing our distant possessions, and, second, to the Central Government at home, who would thus have in the compass of a modest library a synopsis of the history, manners, customs, and religious beliefs of the innumerable races composing the British Empire. In a word, we should have at hand the means of understanding the motives which influence the peoples with whom we are constantly dealing, and thus be able to avoid the disagreements arising from ignorance of their cherished prejudices and beliefs." He then referred to the Bureau of Ethnology in Washington, which was created with the quick decision of a practical people when they realised that they had at their doors a race that was fated to disappear within a measurable time, and that it was their duty to record the history, beliefs and culture of the vanishing American Indian before the opportunity had passed away for ever.

Prof. Max Müller, at the meeting of the British Association which was held at Cardiff in 1891, is reported to have said: "Our American friends have perceived that it is a national duty to preserve as much as can still be preserved of the languages and thoughts of the indigenous races who were the earliest dwellers on American soil. They know that the study of what might be called intellectual geology is quite as important as that of terrestrial geology, and that the study of the lower strata contains the key to a right understanding of the higher strata in the growth of the human mind. Coming generations will call us to account for having allowed the old world to vanish without trying to preserve its records. Some years ago I had succeeded in persuading a Secretary of State for the Colonies that it was the duty of the English Government to publish a series of colonial records, containing trustworthy information on the languages, customs, laws, religions and monuments of the races inhabiting the English colonies. Lord Granville saw that such an undertaking was a national duty, and that the necessary funds should be contributed by the various colonies. Think what a magnificent work this would have been! But while the American Government has pushed forward its work, Lord Granville's scheme expired in the pigeon-holes of the Colonial Office. America may well be proud of Major Powell, who would not allow the treasures collected by various scholars and Government officials to moulder and perish."

The splendid series of reports and the collections of ethnological specimens in the National Museum at Washington, attest to the ability with which this department is conducted. The appropriation by Congress for the fiscal year 1891-92 "for the purpose of continuing ethnological researches among the American Indians" was 50,000 dols. During the same year six ethnologists and seven archæologists were on duty in the field, besides the work done in the Bureau in Washington.

Mr. Read, however, did not propose that in England we should found a Bureau on precisely the lines of the American one. The conditions of the two countries are not sufficiently alike, but the point he urged was: "If the Government of the United States thinks it worth while to be at so much pains, and to incur such an outlay, in order to place on record the history of the one race with which they have to deal, how much more is it the duty of Great Britain to attempt some record of the many vanishing or, at any rate, quickly-changing races within her borders? I would not only say that it is a duty, but I contend that it would be greatly to the interest and profit of England to institute an ethnographic survey of the native races within and upon the borders of her empire. Colonial history is not very ancient—some of it very recent indeed; but how common it is in the history of almost all our colonies to find skirmish after skirmish with the natives arising from ignorance of the native customs and beliefs on the part of the white man, resulting in much trouble to the latter, and, in far too many cases, in the annihilation of the unfortunate natives. The study of ethnology would not entirely prevent such misunderstandings, but it would tend to remove them more quickly if they should occur. An officer who, possessing other qualifications, applies himself to the systematic study of the peoples around him, so that he can readily enter into their methods of thought, and interpret their actions as well as their words, is, I contend, a more valuable agent than one who merely gives his mind and his time to his strictly official business, and his work should be considered of greater value by his superiors at home." Mr. Read alluded to the attempt in this direction of one of the Governments of India, the Madras Presidency, and the labours of Mr. Man and Mr. Portman in the Andaman Islands, Sir Harry Johnston in Africa, and of Sir William McGregor in New Guinea. He advocated (1) that the reports should be systematised and on a uniform method in an office in London; (2) that such work should be held to be part of the duties of the officer on duty abroad; and consequently (3) the officer should obtain credit for such work when well done.

The following resolution was referred to the Council of the British Association: "That it is of urgent importance to press upon the Government the necessity of establishing a Bureau of Ethnology for Great Britain, which, by collecting information with regard to the native races within, and on the borders of, the Empire, will prove of immense value to science and to the Government itself." The Council subsequently appointed a Committee consisting of the President (Lord Lister) and General Officers, with Sir John Evans, Sir John Lubbock, Mr. C. H. Read, and Prof. E. B. Tylor. The report of this Committee was presented to the Council of the Association at the Toronto meeting. It dealt with the urgency, so far as science is concerned, of the need of collection of facts and with the benefit to the Government of these inquiries. Finally it was pointed out that "the collecting of the necessary information for the Bureau could be done with but little expense and with a very small staff only, if the scheme were recognised and forwarded by the Government. The Bureau itself, the central office, would be of necessity in London. The Colonial Office would obviously present some advantages. The British Museum has been suggested, with good reason, and there appears to be no insuperable difficulty if the Trustees are willing to undertake the responsibility of controlling such a department. The staff would not be numerous. A director accustomed to deal with ethnological matter would necessarily direct the conduct of inquiries, and until the material assumed large proportions two or three clerks would probably suffice. If the value of the results were considered to justify it, the increase of the area of operations over the world would probably call for additional assistance after the Bureau had been at work for a few years" The Council resolved that the Trustees of the British Museum be requested to consider whether they could arrange for the proposed Bureau to be established in connection with the Museum; and if they are unable to sanction this proposal, that the authorities of the Imperial Institute be requested to undertake its establishment.

The present writer remarked some years ago:—"Such a Bureau would serve as a great stimulus to those who are interested in native races, but who require encouragement and direction. There can be little doubt that an immense number of isolated observations are lost for the lack of a suitable depository, the observers being fully aware that these are too casual to be of

much value; when accumulated, however, the case is very different. Were it known that a record of any obscure or rarely observed custom would be duly filed and classified and be readily available to any one who was studying native folk-lore, the probability is that many memoranda which otherwise would be lost would find their way to the Bureau. It cannot be too often or too strongly insisted upon, that now is the time for the collection of all anthropological data in every department of that far-reaching science. To many, results alone are interesting, and there is too frequently a danger to generalise from imperfect data. Posterity will have plenty of time in which to generalise and theorise, but it will have scarcely any opportunity for recording new facts. This century has been one of most rapid transition. The apathy of our predecessors has lost to us an immense amount of information: let not this reproach be applied to us by our descendants."

A decade ago, that distinguished Indian officer Major R. C. Temple wrote: "I have no hesitation in saying that to us Englishmen such studies are not only practical, but they are in some respects of the first importance. The practices and beliefs included under the general head of folk-lore make up the daily life of the natives of our great dependency, control their feelings, and underlie many of their actions. We foreigners cannot hope to understand them rightly unless we deeply study them, and it must be remembered that close acquaintance and a right understanding beget sympathy, and sympathy begets good government; and who is there to say that a scientific study which promotes this, and, indeed, to some extent renders it possible, is not a practical one?" A. C. HADDON.

INSECTS AND YEASTS.[1]

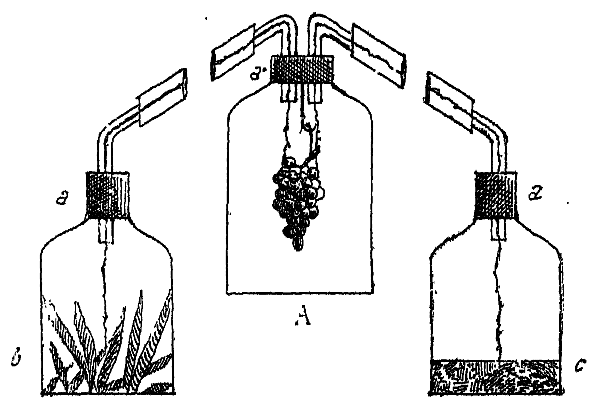
IN the Portici Laboratory for Agricultural Chemistry, Dr. Amedeo Berlese has been making interesting investigations on the manner in which some insects—ants and flies especially—contribute to the diffusion, preservation and multiplication of alcoholic ferments.

It had been formerly observed by Dr. Berlese that on the trunks, both of fruit and forest trees, hidden in the fissures of the bark, the cells of alcoholic yeasts (*Saccharomyces apiculatus* and *Saccharomyces ellipsoideus*) are commonly found. It was natural to suspect that ants, which are constantly travelling up and down trunks and branches, and perhaps also flies, should be among the chief agents in disseminating yeast cells on trees. Dr. Berlese had also observed that these cells are often more numerous on the sunny side of the trees, where insects, especially flies, are likely to linger.

The first series of experiments was to show that ants, starting from an infected soil, and being themselves infected with yeast cells, carry them for a distance up stems and branches, infecting the fruits which they visit, and thence travelling further may carry on the yeast-infection into a sterilised soil.

The apparatus used was very simple (Fig. 1). Inside a large glass jar A, well closed and carefully sterilised, a bunch of grapes was hung, after due sterilisation by successive washing and immersion in carbon disulphide and boiling water. The jar containing the grapes communicated by means of two long glass tubes (about 1·30 m. each) with a glass bottle on each side. These long tubes and the bottles were also carefully sterilised, and connected, by means of corks, so as to form, together with the central jar, a closed system, into which, however, air could penetrate after filtering through sterilised cotton wool. Fourteen of these combinations were prepared, into each of which, in one of the side bottles B, non-sterilised substances were introduced, probably containing yeast cells, such as soil, bark of vines, bark of vine-poles and of oak-trees. In the second side bottle C, the same substances were introduced, but after careful sterilisation. Inside the long tubes were put slender vine branches connecting the substances in the side bottles B and C with the grapes in the central jar A. These vine branches, previously sterilised, were the paths along which the ants were to travel on their way from the infected material in B to the grapes in A, and thence onwards to the sterilised material in C. Before introducing the insects it was verified that each apparatus was internally sterile. Some apparatus were left without insects during all the time of the experiments for more than two months, in order to show that where no insect had been introduced the grapes remained sterile, bearing on their surface neither moulds, nor yeasts, nor bacteria.

Large numbers of ants were collected from the trunks of trees. One species—the *Cremastogaster scutellaris*—was preferred, because it lives in trees, and is very common on vines and vine-poles. The ants were collected with due precaution into sterilised glass vessels, and thence introduced into the bottle B of each apparatus, in numbers varying from a minimum of about 100 to a maximum of about 5000. In the bottle B the ants remained for a few days, then gradually and guardedly advanced up the sterilised branches, congregating and halting at stations on their upward way in the long tubes; generally about two days passed before the first ants appeared on the sterilised grapes in A; thence they passed down the second tube into the bottle C. In this way, starting from B, the most adventurous of the ants which reached C, had travelled a distance of 3·20 m., about equal to the actual height of many vines from the soil, over which ants must travel when they climb up to visit the grapes. The ants used in these experiments suffered probably from want of ventilation; they attacked the corks in efforts to escape, and congregated in great numbers near the cotton wool through which the outer air filtered. Many, however, visited the grapes in search of food, biting the surface of the berries, or absorbing the juice where these had been purposely punctured. In one apparatus where the grapes were unripe, their acid juice proved rapidly poisonous to the ants: an interesting observation, for it gives evidence in favour of the protective character



B FIG. 1 C

of the acids existing in fruit juices before maturation. A small number of ants reached the bottle C. After ten or twelve days most of the ants were dead, and the experiments were ended. The grapes and the materials in C, that had been previously sterilised, were now separately tested to see if through the agency of the ants they had been infected with yeasts. The grapes were removed from the jars with due caution to prevent air-infection, and after shaking off gently all insects still adhering to the fruit; whole berries or small portions of the stalks of the bunches were dropped, without delay, into test-tubes containing sterilised grape-must; and the plugged test-tubes were then left in the thermostat for several days, at a temperature favourable to alcoholic fermentation.

The results obtained are remarkable. In the ten experiments in which ants were introduced, the infection of the grapes in A, and of the material in C, with yeasts and moulds was evident; but varied chiefly according to the various nature of the places from which the ants originally came, and also with the nature of the non-sterilised material in B. When the ants came from a vineyard, and the material in B was ordinary soil or bark of vines or of vine-poles, the germs conveyed to the grapes in A, and to the sterilised material in C, were chiefly moulds together with *Saccharomyces apiculatus* and *ellipsoideus*; *S. apiculatus* was far more abundant than *ellipsoideus*. In one case, when B contained oak bark and the ants had been collected on oak trees, the infection of the grapes and of the material in C showed abundance of *Saccharomyces apiculatus*, with some *S. ellipsoideus* and *S. pastorianus*. When the ants and the bark in B came from olive-trees no yeasts were observed in the

[1] Rapporti fra la Vite ed i Saccaromiceti. Ricerche sui mezzi di trasporto dei Fermenti alcoolici. Amedeo Berlese. *Rivista di Patologia Vegetale e Zimologia*, 1897.

test-tubes. Moulds were in all cases abundant. In those cases where the grapes had been left in the apparatus some days after the ants were dead, moulds developed rapidly on the grapes, and probably destroyed all the yeasts; for in the test-tube cultures moulds were abundant, and no yeasts were observed.

Many experiments were carried out by Dr. Amedeo Berlese to prove that yeasts are abundantly distributed through various kinds of flies.

Small pieces of meat, carefully sterilised by washing in sublimate solution and then in water, were exposed on a terrace, some inside a close wire net which prevented contact with insects, and others so as to favour the visits of flying insects only. Several individuals of the *Sarcophaga carnaria* were noticed visiting the exposed meat. After two hours' exposure to the flies, and thirteen hours' exposure to the air, the pieces of meat were dropped into test-tubes containing sterilised must, and the sediments obtained after fermentation examined for yeasts. It was found that whenever the meat had been exposed to flies, yeasts were far more abundant than when the flies had been excluded. *Saccharomyces apiculatus* was the yeast that appeared more abundantly disseminated by the meat-flies; far ess abundant was *Saccharomyces ellipsoideus*. It was calculated that the quantity of yeasts carried to a piece of meat by flies in a given time is about twenty-six times the quantity that would be carried by air alone.

In other experiments, flies were made to visit grapes that had been previously carefully sterilised. The flies were attracted to the grapes by concealing near them, but so that the flies could not touch them, pieces of meat. The flies that were chiefly attracted and alighted on the grapes were *Sarcophaga carnaria*

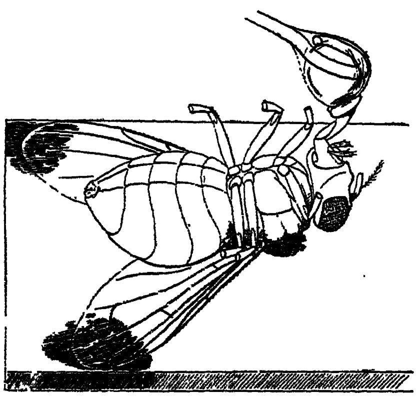


FIG. 2

and the blue meat-fly, *Calliphora erythrocephala*. The grapes were found abundantly infected with *Saccharomyces apiculatus*, and in a far minor degree with *S. ellipsoideus* and *S. pastorianus*; moulds and *Dematium* were abundant. In control experiments, where flies had not been allowed to touch the grapes, these contained no yeasts. Strong infections with *S. apiculatus* were also obtained by imprisoning blue meat-flies and *Sarcophaga* inside a wire netting in which sterilised grapes had been hung.

On experimenting in a similar manner with the cellar-midge or vinegar-fly, the *Drosophila cellaris*, it was found that it conveyed in great abundance *Saccharomyces ellipsoideus* and *pastorianus*, and also in smaller quantity *Saccharomyces apiculatus*, besides, of course, *Bacterium aceti*, *Dematium*, and many moulds. Sterilised grapes, when visited by the cellar-midge, cause rapid fermentation of the grape-must in which they are sown.

How do winged insects convey yeasts?

Several experiments with various kinds of flies showed that ferments are often more abundant in the bodies of the flies than in their legs and feet. It is also easy to observe the presence of cells, similar to those of yeast, in the excrements of flies. Dr. Berlese was thus brought to study experimentally the passage of yeast cells through the digestive tract of meat-flies and cellar-midges.

The best experiments to prove the passage and the preservation of yeast cells inside the bodies of insects were made with meat-flies. The living flies, as shown in Fig. 2, were laid on their backs on a glass plate and pinioned there by glueing the extremities of their wings to the glass; the legs of the fly thus secured were removed, in order to prevent infection of the external part of the body by the legs. The external part of the body of each fly was carefully sterilised by repeated brush washings with corrosive sublimate solution. Thus fixed on its back, externally sterilised, and secured inside a glass Petri-box, each fly was regularly fed for several days, either with sterilised grape-must, or with pure cultures of yeasts in must. The excretions of the fly were easily collected by means of a sterilised platinum loop, and examined by inoculation in sterilised must for yeast cells. This method gave full assurance that any living cell found in the excretions had passed through the intestine. The pinioned flies did not lose their desire for food, but eagerly sucked up with their proboscis the grape-must presented to them on the platinum loop, living on for several days, when kept at a temperature of from 18° to 20° C. It was observed that when the flies had been kept fasting they eagerly and completely sucked up all the yeast-laden must offered to them; but when the flies had been well fed they became more dainty, and sucked only the liquid portion of the sweet drop, leaving a residual semi-solid lump consisting largely of yeast cells; this would prove that in the act of suction with the proboscis, flies can probably at will use a filtering process to separate the solid from the liquid parts. In numerous experi-

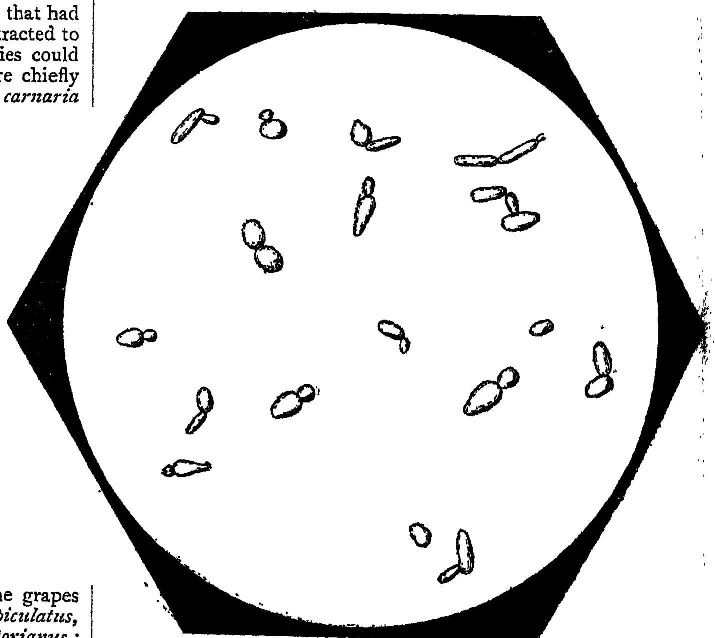


FIG. 3.

ments with blue meat-flies, flesh-flies, and cellar-midges, it was proved that when the flies are fed with sterilised must the excreta contain no yeasts, especially if gathered after repeated evacuations; but if, on the contrary, the flies are fed with pure cultures of *Saccharomyces apiculatus*, or of other yeasts, the excreta soon contain in great numbers the yeast that was in the food. The yeast cells contained in the excreta are living, for, when sown in suitable liquids, they multiply with great rapidity. Figs. 3 and 4 give an example of the multiplication, during eighteen hours, of the cells of a yeast (*Saccharomyces pastorianus*) emitted by a blue meat-fly, which had been fed with grape-must containing that yeast. The vitality of the yeast cells is also unimpaired when given to the flies with meat juice containing no sugar. The temperatures prevailing during ingestion of yeast cells in flies influence the rapidity of their multiplication in the excreta. Thus, when *Saccharomyces apiculatus* is given to the flies, the cells in the excreta are in active germination when the prevailing temperature is from 20° to 25° C.; on the other hand, germinating cells are scarce if the fly has been kept at 8° to 10° C. This suggests that inside the digestive tract of the insect external conditions may influence the multiplication of the yeast cells. To prove this, some blue meat-flies were fed only once

with a pure culture of *Saccharomyces apiculatus*, and then for the remaining days of their life with sterilised grape-must. Comparing the approximate number of cells of *S. apiculatus* originally given in the food with the great numbers of the same cells gathered successively in the excreta during several days, it was evident that the yeast cells had greatly multiplied. It was calculated that in the droplet of must containing the *S. apiculatus*, with which each fly was first fed, the number of yeast cells must have been about 500,000; now, continuing to feed these flies with sterilised must, the number of yeast cells expelled each time from the intestine was reckoned to be from 400,000 to 600,000, and perhaps more. In one of these pinioned flies, that lived for eight days, the yeast cells calculated for one excretal drop on the seventh day of confinement were more than 2,500,000; this fly, which had been fed originally with about 500,000 yeast cells, must have emitted, during the eight days in which no yeast was given to it, about 35,000,000 cells. In some cases, especially when excretion was not frequent, the excrementitious droplet was one mass of *S. apiculatus*. There can be no doubt, therefore, that the yeast cells increase in numbers while inside the body of the insect. This was further proved by pinioning, in the manner described, some blue meat-flies just caught, feeding them exclusively with sterilised must, and examining all the excreta during the remaining days of their life;

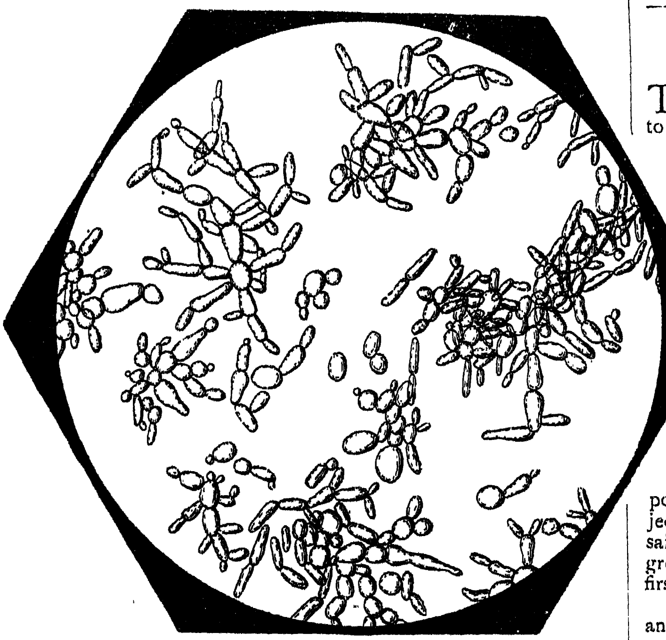


FIG. 4.

it was found that *S. apiculatus* cells, not very abundant at first, increased greatly during the succeeding days; in these cases all the yeast cells excreted were derived from the *Saccharomyces* contained in the insect before captivity, gathered with its food whilst in the free state.

On pinioning blue meat-flies in a Petri-box, and feeding them exclusively with sterilised must, *S. apiculatus* appears commonly in the excreta, but rarely is *S. ellipsoideus* observed. This may be due both to the scarcity of *S. ellipsoideus* in the usual food of the meat-flies, and to the struggle between the various yeasts and other organisms that develop in the digestive tube. On feeding a blue meat-fly only once with a mixture of *S. apiculatus* and *S. mycoderma*, and then feeding it with sterilised must exclusively, it was observed that at first the excreta contained both the yeasts in about equal proportions; but gradually *apiculatus* had the upper hand on continuing to feed with must; but if the insect was made to fast, the quantity of *S. apiculatus* in the excreta diminished rapidly, and those of the *mycoderma* greatly increased. This shows how greatly the conditions inside the intestine of the insect must influence the development of the different yeast germs.

Some observations by Drs. Amedeo and Antonio Berlese, on the internal anatomy of flies (*Drosophila cellaris* and common flies), contribute much to explain how it is that the yeasts can accumulate in great numbers and multiply inside the organism of these insects. It is known that the juices sucked up by means of the proboscis do not go directly into the intestine, but are stored up in the crop, or *ingluvies*, a special organ which, through a long tube, communicates with the œsophagus, at the upper part of the digestive tract. On examining the crop of many flies, it was found replete with a syrupy liquid, a concentrated sugar solution, capable of rapidly reducing Fehling's solution, in which yeast cells are observable, besides *Dematium*, *Torulæ*, *Bacteria* and ciliated infusoria. It is probable that in the sugary solution contained in the *ingluvies* (unless the solution be too concentrated to permit the process) the multiplication of the yeast cells must chiefly occur.

The experiments of Dr. Amedeo Berlese thus prove conclusively the great part that insects, especially ants and several kinds of flies, take, not only in the distribution (as was hitherto known), but also in the preservation and multiplication of alcoholic ferments. Insects, far more than atmospheric air, contribute to the dissemination of yeasts, which they convey rather internally than externally. There is, moreover, reason for believing that during the cold season some yeasts are chiefly preserved and, perhaps, increased within the organism of insects.

ITALO GIGLIOLI.

TEN YEARS' WORK OF THE ROYAL GARDENS, KEW.[1]

THE completion of the tenth annual volume of the *Kew Bulletin* has made it desirable to publish a detailed index to the whole series. As the number of volumes has increased it has become more difficult to find the information they may contain on any particular subject.

The opportunity may be taken to pass in review briefly the more important subjects which have been treated. This will have the more interest as the period covered has been one of more than usual activity in the development of our tropical possessions.

Kew, from its first establishment as a national institution in 1841, has always been applied to by men of business desirous of engaging in new industries. Response to individual inquiries gradually came to be regarded as insufficient, and a demand arose for the prompt publication for general use of any information likely to be of service to those engaged in colonial pursuits. With this object the first number of the *Bulletin* was issued in January 1887. But it was also intended to serve another purpose. When public attention is engaged by any particular subject, inquiries about it are numerous. To say all there is to be said about it, once for all, in the pages of the *Bulletin* effects a great saving in labour. To quote the prefatory notice to the first number:—

"It is hoped that while these notes will serve the purpose of an expeditious mode of communication to the numerous correspondents of Kew in distant parts of the Empire, they may also be of service to members of the general public interested in planting or agricultural business in India and the Colonies."

On March 18, 1887, the First Commissioner of Her Majesty's Works and Public Buildings (Mr. Plunket) informed the House of Commons:—"In response to the demands for the publication more speedily than in the annual report of information received from abroad, I have sanctioned the publication of a monthly bulletin, which can be purchased for a small sum."

Publication was originally intended to be "occasional." It has not been found practically possible to keep up an absolutely regular monthly issue. This, however, has been approached as nearly as circumstances would allow.

The original intention was to confine the *Bulletin* to colonial and commercial information. The suggestion of a larger scope having been raised in Parliament, especially with regard to reports on expeditions, the materials collected by which had been entrusted to Kew, to notices of interesting plants or objects received and the important plants sent out, Mr. Plunket further decided that the "*Bulletin* . . . should be made the vehicle of all printed matter suitable for its pages, which it is desirable to issue from Kew." As a sequel the *Bulletin* became, what it remains, a continuous record of Kew work in all its various aspects.

[1] Reprinted from the *Kew Bulletin of Miscellaneous Information*, No. 120.

BOTANIC STATIONS.

The establishment and development of the institutions known as Botanic Stations belongs almost entirely to the period under review. These stations were first suggested in 1885 to meet the special requirements of the smaller islands in the West Indies (*K.B.*, 1887, June 1-12), where "a great want was felt for reliable information on the culture of new economic plants and plain practical hints as to the best means to be employed for rendering them of the greatest value" (p. 7). This information was intended to be supplied by a regular system of bulletins supplemented by the maintenance of stations with nurseries attached for supplying seeds and plants. The officers in charge of the stations were men selected mostly from Kew, with a sound knowledge of gardening and capable of showing experimentally the conditions under which tropical economic plants might best be utilised as objects of remunerative industry.

The scheme met with the approval of the late Earl of Derby, and has been supported by successive Secretaries of State.

The details of its working have devolved largely on Kew, which has been continuously drawn upon for men, plants, advice, and information.

The first Botanic Stations were started at Grenada and Barbados, in 1886. These were soon followed by similar stations at St. Lucia (1889), Dominica and other islands in the Leeward Group (1889), St. Vincent (1890), and afterwards at British Honduras (1894). There are now nine stations in all in the West Indies.

The Grenada station was established on a spot just outside the town of St. George, described by the Governor as a "good site, well watered, accessible, and apparently suitable in every way." The first grant was 300*l.*, with a further sum of 1000*l.* towards establishing and laying out the garden and providing a house for the curator. The objects of this garden were stated as follows: "To introduce and distribute plants of great economic value, to supply practical hints respecting new and promising industries, and to develop and improve existing minor industries" (*K.B.*, 1887, June 12). An account of the interesting station at St. Vincent, established on the site of the old botanic garden that existed from 1765 to 1823, was given with a drawing of the curator's house (*K.B.*, 1892, 92). Several references are made to the excellent work done in the Botanic Garden at Dominica, which promises to be one of the most attractive and useful in the West Indies (*K.B.*, 1893, 148).

Following the example of the West Indies, there have been established five Botanic Stations on the West Coast of Africa. The earliest was started at Lagos by Sir Alfred Moloney in 1888; the next at Aburi on the Gold Coast, in which Sir W. Brandford Griffiths took a deep personal interest, in 1890. Since then stations have been established both at the Gambia (1894), in the Niger Coast Protectorate (1891), and at Sierra Leone (1895). A further station has been established in Fiji by the efforts of Sir John Thurston (1889). The results attained by these Botanic Stations have been so promising that a strong wish has been expressed by the local authorities to obtain similar institutions at Bermuda, Bahamas, and the Seychelles.

FRUIT TRADE.

One of the most interesting developments in Colonial enterprise in recent years has been the increasing trade in fruit. Jamaica led the way, largely owing to the encouragement of the late Sir Anthony Musgrave, by supplying the United States with bananas and oranges that hitherto had had no local commercial value. The Jamaica fruit trade is now of the annual value of more than half a million sterling, and employs a considerable number of vessels wholly engaged in it. The trade in fruit between the Southern Colonies of the Old World (the Cape and Australia) and the mother country, is another instance of commercial activity in a new direction. It is not ten yet years old, but the value of the fruit annually imported is very considerable. The first steps in this direction were undertaken on the suggestion of Kew, and led to the excellent display of fruit made at the Colonial and Indian Exhibition in 1886. This showed so strikingly the capabilities of the Australian Colonies and the Cape to ship fresh fruit to this country during the winter months, that considerable effort was made to establish what is now regarded as an important trade.

In the *Bulletin* for the years 1887 and 1888 will be found a summary of information not accessible in any other form in regard to the capabilities of various parts of the Empire for the production of fruit. This was brought together through the aid of reports obtained by the Secretary of State for the Colonies, and is still the most authoritative source of information on the subject. The efforts now being made to ship various tropical fruits from the West Indies direct to this country is another direction in which great results may ultimately be attained. The popular taste for the consumption of bananas is increasing. It has been shown that many such fruits can be brought to the home country in a fresh condition and find a ready market.

Information is also given respecting certain kinds that have been introduced with the aid of Kew from the West to the East Indies (*K.B.*, August 1, 1887). Among these the Tree Tomato, the Chocho, and the Cherimoyer have proved useful additions to the food supply of hill stations in India and Ceylon. On the other hand new varieties of bananas and mangoes, the Durian and the Mangosteen, have been transferred from the East to the West Indies.

DECADES KEWENSES.

Under the title of "Decades Kewenses" descriptions of plants new to science have reached the thirtieth decade. These are based on specimens contributed from every region on the earth's surface from the extreme heights of Tibet to the shores of the remotest islet in the Pacific Ocean. Further, owing to the increased impulse to exploration and commercial enterprise in Tropical Africa, it was thought desirable to publish at once, but in a separate series, brief diagnoses of new species. This has been done in the "Diagnoses Africanæ" (1894 to 1895).

FLORAS.

Besides these the vegetation of special regions investigated at Kew as the result of collections communicated by expeditions and travellers, appear under numerous headings as the Flora of the Solomon Islands (*K.B.*, 1894, 211; 1895, 132, 159); of Aldabra Islands (*K.B.*, 1894, 146); of Formosa (*K.B.*, 1896, 65); of St. Vincent and adjacent islets (*K.B.* 1893, 231); of the Gambia Delimitation Commission (*K.B.*, 1891, 268; 1892, 45); of the Sikkim-Tibet frontier (1893, 297); of Tibet (*K.B.*, 1894, 136); of the Hadramaut Expedition (*K.B.*, 1894, 328; 1895, 315); Siam plants (*K.B.*, 1895, 38). Amongst investigations of the economic products of various regions are articles on the Agricultural industries of the Gambia (*K.B.*, 1889, 242), Economic plants of Madagascar (*K.B.*, 1890, 200); Agricultural resources of Zanzibar (*K.B.*, 1892, 87); Economic plants of Sierra Leone (*K.B.*, 1893, 167); and Plant industries of Lagos (*K.B.*, 1893, 180).

ORCHIDS.

The cultivation of orchids is one of the most prominent features of English horticulture. Every part of the world is ransacked for them by collectors. Of no family of plants have more species been got together in a living state, and in no country are a greater number maintained under cultural conditions than in England. During his lifetime, the late Dr. Reichenbach, Professor of Botany at Hamburg, was the acknowledged authority for their nomenclature. On his death in 1889 vigorous public pressure was brought to bear on Kew to take up his work. This was done, though not without difficulty, in addition to its other duties, and in 1891 the publication of technical descriptions of new species was commenced. Twenty decades of "new orchids" have been published in the *Bulletin*.

HORTICULTURE.

Of horticultural interest a list enumerating 766 species and varieties of orchids that flowered at Kew during the year 1890 has been published (*K.B.*, 1891, 52), affording useful information as to the time and duration of the flowering period of orchids cultivated in this country. The highest number of species flowered in one month was 125 in May; the lowest was 85 in January. Some species, as for instance *Cypripedium longifolium*, *Masdevallia pulvinaris*, and *Odontoglossum crispum*, were in flower all through the year.

The cultivation of tropical and sub-tropical plants on the Riviera was described (*K.B.*, 1889, 287), with notes on the principal palms, cycads, bamboos, agaves, and other succulent plants. To this was added a list of some of the most interesting other species established on the Riviera, revising in many cases the names under which they had hitherto been recognised. A further contribution was made to this subject by a paper written by Mr. J. G. Baker, F.R.S., on the agaves and arborescent iliaceæ on the Riviera (*K.B.*, 1892, 1). As few botanists have attended much to these plants, it has been very difficult for

cultivators to obtain names for their collections. A correct determination of cultivated Riviera plants is also of value to Kew, as it assists in the interchange or purchase of new and desirable specimens required for the establishment.

An important paper on horticulture and arboriculture in the United States, prepared by the curator, Mr. G. Nicholson, whilst on a visit, as a judge in horticulture at the Columbian Exposition at Chicago (*K.B.*, 1894, 37), has rendered it possible to obtain a more complete representation of the trees and shrubs of the United States in the Arboretum of the Royal Gardens, and has brought before horticulturists in this country many interesting plants that had not hitherto received the attention they deserved. Nearer home, a paper on Horticulture in Cornwall (*K.B.* 1893, 355) affords a fairly representative picture of the possibilities of Cornish horticulture, where, owing to the mildness of the climate, types of the vegetation of New Zealand and the Himalaya do better even than under glass at Kew. The "cultivation of vegetables for market" and the possibilities of market gardening in Great Britain (*K.B.*, 1895, 307) discusses an important economic problem.

Among other horticultural subjects dealt with are the storing of home-grown fruit (*K.B.*, 1895, 31, with an illustration of a fruit room), and a detailed account of the prune industry in France and California.

PLANT DISEASES.

The diseases of cultivated plants is a subject on which the aid of Kew is frequently sought on behalf of Colonial Governments by the Secretary of State for the Colonies. The investigation of fungoid diseases often demands considerable time and attention on the part of members of the Kew staff, while those caused by insects render it necessary to secure the assistance of specially qualified experts to whose courtesy this establishment is greatly indebted. The several diseases that have affected the sugar-cane in the West Indies, Queensland, and Mauritius have been described in a series of important articles extending over several years (1890-96), whilst diseases such as those affecting arrowroot in St. Vincent, bananas in Fiji, cocoa-nut in British Honduras, coffee in East Africa, onions in Bermuda, wheat in Cyprus, pepper in Mysore, potatoes in India, vanilla in the Seychelles, have also been carefully dealt with. Of considerable practical value are articles on the preservation of grain from weevils (*K.B.*, 1890, 144), and on the well-known plant malady called "anbury" and "finger and toe," which attacks turnips (*K.B.*, 1895, 129). It is shown that free acid present in the soil is favourable to the disease, while a free alkali is unfavourable.

FIBRE PLANTS.

The large and increasing interest taken in fibre plants, and the numerous references made to this establishment on the subject, rendered it desirable to place within reach of cultivators in India and the Colonies a summary of information respecting them. This is contained in a series of articles begun in 1887, and continued with more or less regularity to the present time. The total number amounts to about seventy. As might be expected, those of chief importance relate to Sisal hemp and Ramie, or China grass, subjects which have received much attention in various parts of the Empire. These articles are of value, not only in encouraging the cultivation of plants yielding fibres likely to be in actual demand, and yielding remunerative results, but in preventing expenditure upon those that are known to be useless.

Many fibres have been traced to the plants yielding them for the first time. For instance, the Mexican whisk, or *Raiz de Zacaton*, was identified, from specimens communicated by the Foreign Office, at the root of a species of *Epicampes*, a grass distributed over the highlands of Mexico. The plants yielding the fibre called Istle, used, not for rope making, but as a substitute for animal bristles in the manufacture of cheap nail and scrubbing brushes, were found to belong to a group of Agaves with short leaves, of which *Agave heteracantha, Zucc.*, is the type. The first information respecting African bass, a fibre obtained from *Raphia vinifera*, was published in the *Kew Bulletin* (*K.B.*, 1891, p. 1). This is now a regular article of export from our African Colonies; and the same thing may be said of the bass fibre obtained from the Palmyra palm in Ceylon (*K.B.*, 1892, 148), and of Madagascar Piasava yielded by a new species of *Dictyosperma* (*K.B.*, 1894, 358). A continuous account of the hemp industry in Yucatan, and of the similar industry lately started in the Bahamas, is given over the whole period. The origin of the white-rope fibres which appeared in commerce as Bombay aloe fibre, and as Manila aloe fibre, have been traced to *Agave vivipara*, a New World species now naturalised and fairly abundant in many parts of the East Indies (*K.B.*, 1893, 78).

The recent attempts to extract and to utilise the valuable fibres contained in the China grass (*Boehmeria nivea*), and Ramie or Rhea (*B. tenacissima*), have been placed on record in a series of articles which have been of considerable service to manufacturers in this country and also to our planting Colonies. The habits and requirements of the plants and the conditions necessary for their successful cultivation have been carefully discussed.

RUBBER PLANTS.

The investigation of rubber-yielding plants has resulted in drawing attention not only to new sources of supply, but in increasing the quantity available for commercial purposes. The remarkable rubber industry started in the Colony of Lagos in 1889 is described (*K.B.*, 1895, p. 241), and a figure is given of the plant, which hitherto had not been known as a source of commercial rubber. The Lagos rubber industry in two years developed into an export value of nearly 400,000*l*. A somewhat similar industry has been started on the Gold Coast by the efforts of Sir Alfred Moloney, with exports in 1893 of the value of 218,162*l*. Practically all the more important sources of commercial rubber are reviewed, while particulars respecting two rubber plants, such as *Forsteronia gracilis* in British Guiana, *F. floribunda* in Jamaica, and *Sapium glandulosum* in the United States of Columbia, are also given. It may be added that information is desired by this establishment respecting the plants yielding the Esmeralda rubber of Guiana (*K.B.*, 1892, 70) and that exported from Matto-grosso in Brazil. There is a doubt as to the distinction, if any, existing between caoutchoucs yielded respectively by the Ule and Tuno trees of Central America. One of these is usually referred to *Castilloa elastica*, but botanical specimens are necessary of each tree to definitely decide the point.

SPECIAL ARTICLES.

These include the results of investigations made at Kew into plants yielding Paraguay tea, or maté, so largely consumed as a beverage in South America (*K.B.*, 1872, 132); vanilla-yielding plants cultivated in tropical countries (*K.B.*, 1895, 169); the plants yielding Sisal hemp, (*K.B.*, 1892, 21); the timber of the Straits Settlements (*K.B.*, 1890, 112); the species and varieties of *Musa* cultivated for food or ornament (*K.B.*, 1894, 229); tropical fodder grasses (*K.B.*, 1894, 373: 1896, 115); Chinese white wax (*K.B.*, 1893, 84); the arrowroot industry of St. Vincent (*K.B.*, 1893, 191); tuberous Labiatæ (*K.B.*, 1894, 10); Canary rosewoods (*K.B.*, 1893, 133); American ginseng (*K.B.*, 1893, 71); palm weevil in British Honduras (*K.B.*, 1893, 27); and sheep bushes and salt bushes (*K.B.*, 1896, 129). In addition several articles have appeared describing the various forms in which tea is met with in European and Asiatic commerce. Pu-erh tea is made into balls as big as a man's head, or into cakes; compressed or tablet tea is manufactured from tea dust by steam machinery; while another form known as brick tea is used in Chinese Mongolia and Tibet. Lao tea is not used for making an infusion, but prepared wholly for chewing purposes. A pickled tea, called Leppett tea, is eaten as a preserve with other articles. The white tea of Persia has been shown to consist of the undeveloped leaf-buds of China tea thickly coated with fine hairs giving them a silvery appearance. A singular beverage known as Faham tea is prepared in Mauritius from the leaves of an orchid (*Angræcum fragrans*) (*K.B.*, 1892, 181). This is described as agreeable and used as a digestive; it is even recommended in diseases of the respiratory organs. The leaves themselves mixed with ordinary tea impart to the latter an extremely pleasant perfume.

The discovery of seedling sugar-canes at Barbados (*K.B.*, 1889, 242) has rendered it practicable to raise new serviceable varieties, and probably to improve the yield of this valuable plant. A seedling raised at Kew has yielded excellent results in Queensland, and has been largely propagated under the name of "Kewensis" (*K.B.*, 1896, 167). The possibility of preparing a palatable butter from the oil of the cocoa-nut (*K.B.*, 1890, 230) is an instance of the advance made in the chemistry of familiar vegetable products. Canaigre (*K.B.*, 1890, 63) will probably prove a most valuable tanning agent, while the preparation of cutch from the bark of mangrove trees (*K.B.*, 1892,

227) may bring into profitable use stretches of vegetation in the tropics that have hitherto been regarded as perfectly useless. Amongst new economic plants should be mentioned *Coffea stenophylla*, the highland coffee of Sierra Leone (*K.B.*, 1896, 189), which in certain localities may prove a formidable rival of the Arabian coffee.

The publication of a note on Jarrah timber (*K.B.*, 1890, 188) has led to the extended use of this and similar Australian hard woods for the purpose of paving the carriage-ways of London streets instead of the cheaper but less durable white pine. The collections of Australian timbers in Museum III. were of special service in this direction.

A paper on Natural Sugar in Tobacco (*K.B.*, 1896, 49-55) recorded some scientific facts of great novelty and interest, and solved an important fiscal problem.

DRUGS.

Many little-known drugs have been investigated. The seeds of *Sophora secundiflora* have a singular use among the Indians of Mexico, where they are taken as an intoxicant. Half a seed is said to produce exhilaration followed by sleep lasting two or three days (*K.B.*, 1892, 216).

Derris elliptica, now growing in the Economic House at Kew, yields the Malayan fish poison known as "Aker Tuba" (*K.B.*, 1892, 216). From the account given of Natal Aloes and of the plants supposed to yield this product (*K.B.*, 1890, 163) it appears that it differs in some important respects from the more commonly known Cape Aloes. The discovery of the plant, also in the Kew collection, yielding the true Star Anise of commerce is noticed (*K.B.*, 1888, 173). The manufacture of quinine in India, and the wide distribution at a nominal price of this valuable medicinal agent amongst the natives (*K.B.*, 1890, 29), is one of the most important services which European rule has rendered to the Indian Empire. Paraguay Jaborandi (*Pilocarpus*) is discussed (*K.B.*, 1891, 179) from materials sent to this country by H.M.'s *chargé d'affaires* at Buenos Ayres in 1881. The origin of myrrh and frankincense is discussed in considerable detail (*K.B*, 1896, 86), while the first authentic information respecting the district whence Siam Benzoin or Gum Benjamin of commerce is obtained is the subject of another article (*K.B.*, 1895, 154). Next to Gum Benjamin, Siam Gamboge is the most interesting of Siamese products (*K.B.*, 1895, 139). The peculiar Ai Camphor prepared in China from a shrubby composite, a species of *Blumea*, is described (with a plate) from information supplied by Dr. Augustine Henry (*K.B.*, 1895, 275). The plants yielding the leaves known as coca, and the drug cocaine, with their characteristics, are discussed (*K.B.*, 1889, 1), with a suggestion that a plant long cultivated at Kew (*Erythroxylon Coca*, var. *novo granatense*) might be suited for cultivation at a lower elevation than the type. The little-known Iboga root of the Gaboon and Bocca of the Congo, possessing tonic properties, is traced to *Tabernanthe Iboga*, Baill. (*K.B.*, 1895, 37); the tree yielding the Ipoh poison of the Malay peninsula is identified with that yielding the Upas poison of Java (*K.B.*, 1891, 24); but the remarkable point is brought out that while in Java the Upas tree (*Antiaris toxicaria*) furnishes a very effective arrow poison, in the Malay peninsula the juice of what is regarded as an identical species is apparently innocuous, and the defect is remedied by the use of arsenic.

FOOD GRAINS.

A series of articles on the food grains of India by Prof. A. H. Church, F.R.S. (1888 to 1893), supplements the information contained in his published handbook on the same subject. The materials for these investigations were supplied from the Museums of the Royal Gardens.

MISCELLANEOUS NOTES.

In 1891 a series of miscellaneous notes was begun, in which were recorded appointments on the Kew staff as well as those made on the recommendation of Kew by the respective Secretaries of State to Colonial and Indian Botanical Gardens. The notes also included a record of contributions made to the gardens, herbarium, and museums, the movements of expeditions and travellers engaged in botanical exploration, notices of Kew publications, and facts of interest connected with the daily work of the establishment. Later there were added paragraphs on general economic subjects too short to appear as separate articles. The detailed index now published will afford the means of reference to these scattered notices.

APPENDICES.

The Appendices remain to be noticed. Of these three have been regularly issued at the end of each volume since 1891. Previously the information contained in them had appeared as one of the monthly numbers of the *Bulletin*. (1) Lists of seeds of hardy herbaceous and of trees and shrubs offered in exchange by Kew to Colonial, Indian, and foreign botanical gardens; (2) Lists of new garden plants annually described in botanical and horticultural publications. These are indispensable to the maintenance of a correct nomenclature in the smaller botanical establishments in correspondence with Kew, and afford information respecting new plants distributed from this establishment in regular course of exchange with other botanic gardens; (3) Lists of the staffs of the Royal Gardens, Kew, and of botanical establishments at home and in India and the Colonies in correspondence with Kew.

In Appendix III., 1890, will be found a complete index to the Reports on the Progress and Condition of the Royal Gardens, Kew, from 1862 to 1882. This index is useful as a means of easy reference to the numerous notices respecting economic and other plants.

CORRECTIONS.

In so varied a range of subjects some amount of error, it is hoped not considerable, doubtless exists. A few statements which subsequent research have shown to be probably erroneous must be corrected.

The case of poisoning from Turnsole (*Chrozophora tinctoria*) described in *K.B.*, 1889, 279-280, was in all probability not due to that plant, but to *Datura Stramonium*.

The source of the well-known Chinese preserved ginger, which in *K.B.*, 1891, 5, was attributed to *Alpinia Galanga*, ultimately appeared to be, as pointed out in *K.B.*, 1892, 16, the ordinary commercial plant, *Zingiber officinale*. Some mistake had been made apparently in the plants transmitted to Kew as yielding the commerical product.

The figure of a *Musa* given in *K.B.*, 1894, 247, as *Musa Fehi* may be identical with that species. But all that is certain about it is that it represents *M. Seemanni* of Baron von Mueller.

THE DUKE OF DEVONSHIRE ON SCIENTIFIC EDUCATION.

IN opening a new technical college at Darlington on Friday last, the Duke of Devonshire made some valuable remarks upon the advantages of scientific instruction, and the need for the organisation of secondary education. Subjoined are a few extracts from the *Times* report of the address.

SCIENCE AND ART ESSENTIAL TO COMMERCIAL PROSPERITY.

The case for technical education, and for the improvement of technical education, the case for the adequate provision of the scientific and artistic education of our people, is within our judgment essential to the continued efficiency of our manufacturing and commercial interests, without the prosperity of which the people could not continue either to prosper or even to exist. Science and art now enter so largely into the practical conduct and management of every one of our industries that a knowledge of the principles of science and of art is as indispensable to their successful conduct as the possession of bodily strength is necessary for the working of the raw materials. Take the case of the industries in which you yourselves are specially interested—the mining, the iron, and the steel industries. Science enters into every operation by which you extract coal or iron from the earth; science enters into every process by which you convert coal into coke, into every operation in which iron ore, with the aid of coke, is converted into iron. Again, into every process in which the iron is converted into steel, and into every one of those processes by which steel is converted into the thousand articles in which it serves the purposes of the community, it is science and science only which has created, and which continues to improve, those vast and powerful machines by means of which the heat which is generated from coal is converted into power, and applied to the service of man. In every one of these processes—to speak only of those with which you are most familiar in this district—improvement and development are constantly taking place; and if in any respect

your knowledge of any one of these latest discoveries and any one of these processes is deficient, by that extent you are placed at a disadvantage in the competition which you have to carry on with the other nations of the earth. I am not going to say that the theoretical knowledge of the principles of science is indispensable to every manual worker, but I do not think that it can be denied or doubted that the higher the average intelligence of the manual worker, the more valuable are his labours. It is also an undoubted fact that there are an increasing number of positions, ranging from that of the chief manager of a manufacturing establishment which may employ thousands of hands, to that of the foreman or superintendent of a subordinate branch of such an establishment, to whom the knowledge of what I have spoken is indispensable. It is also undoubted that that supply of knowledge and intellectual ability cannot be found unless we give access to the attainment of such knowledge to the most of the working classes. These are not altogether theoretical speculations, but I think they are at the present moment, at all events, matters of practical Interest.

FOREIGN COMPETITION DUE TO SUPERIOR TECHNICAL INSTRUCTION.

Many of you will remember that last year, or the year before, there was a great deal of discussion on the subject of the intense competition to which some of our principal industries were exposed. Although I believe that this scare was to a great extent exaggerated, I do not think that any one will say it was altogether without foundation, or that to-day the condition of some of our industries does not require close examination, probably some caution, and certainly considerable energy, in order to retain it in its present position. And if this panic, exaggerated as it may have been, has led us to anticipate and to ward off the blow, rather than to wait until it has actually been received, I do not think that it can have done anything but good. I think you ought to remember that even those who have been the foremost in combating anything in the nature of alarm or panic, have been forced to admit that there are certain of our industries on which serious inroads have been made by foreign competition. All, almost without exception, agree that in cases where such successful inroads have been made the cause is, in a great degree, due to the superior excellence of the technical preparation of the workers of foreign countries. I am quite aware that there are many other causes which may, in the opinions of many, be supposed to hamper us in the industrial race; but most of those causes are subjects of a controversial character, into which I do not think I have either time or inclination to enter to-day. But whatever the opinion on the subject of those causes may be, at any rate there can be no reason why we should not address ourselves at once, and with energy, to attempt to remove one cause at least which is obvious, which is patent, which is not controversial, and in the removal of which employers and workmen should seek to co-operate without the slightest antagonism or opposition of interests.

EXTENSION OF TECHNICAL EDUCATION.

It is very satisfactory to know that we have been doing of late years a good deal to remove any inferiority under which we may labour in respect of the technical training of our people. If we compare the position of the technical instruction of the present day with that which existed ten or even five years ago, there is ample ground for congratulation. Many, I think I may say most, of our counties and county boroughs have displayed great energy in framing and carrying into effect large schemes for the scientific education of the people. Public opinion was never at any time so favourable to institutions adapted to provide for the local needs of the districts, even though those institutions might involve the community in considerable expense. The nation realises, as it never has at any previous period, that the welfare of its industry depends upon the training of its workers, and, still more, upon the training of the directors of its industries. It is understood that it is not enough to start a scheme of technical education and to expect that it will go of itself; and the only means for preserving its continued efficiency is an incessant watchfulness, and a readiness to adopt and seize upon every improvement which the development of science or of manufacture itself may suggest. A body of experienced teachers, such as many counties now possess, aided, supported, and encouraged by intelligent committees, is capable at the present day of rendering enormous services not only to your own community, but to the nation at large. We ought to remember that this work is only begun, that whatever progress we have made we are far from having attained the perfection which has been attained by some of our competitors; and if I may recur once more to the subject of competition, I may say that I believe that in the opinions of some of the most competent and thoughtful observers much more alarm is felt on account of what they know has been done on the subject of a scientific and an artistic training of the population of other countries, and by what they know of the inevitable results which will follow from that completeness of training, than from any actual inroad which has yet been made upon our industrial and commercial supremacy.

THE ORGANISATION OF SECONDARY EDUCATION.

But there is, as I believe, an urgent necessity for action, both swift and prudent. While much, I think most, depends upon what may be done by local effort, I admit that something yet remains to be done by the Government with the assistance of Parliament. The progress which we have already made, and the tentative struggle in which we have been engaged for the last few years, have revealed the existence in our educational system of a considerable gap which requires to be filled. All the experts agree, in order that the people should take full advantage of the special scientific courses now provided for them, that they must go to them better prepared than they are now. Your own expert, Mr. Robson, the secretary of the county education centre, has called attention to that point. He says:—"The lesson has been learned by the many which was only realised at that time (a few years ago) by the few—namely, that before specialised technical instruction can be given in an ideal form we require not only a larger supply of competent instructors, but the students must have gone through a course of secondary education not at present available. In other words, there must be an organised system of secondary education provided beyond and above our most admirable elementary school course, instead of the present chaotic jumble existing between the elementary school and the University." Accordingly, I am glad to see from the same report that the county committee of education have devoted a considerable amount of attention to the improvement of the secondary schools in the county. But their powers should be extended, and that was one object of the measure which was brought before Parliament in the session before last. I hope that, at all events, the part of the measure which referred to secondary education will very speedily reappear; and not only reappear, but that some of the difficulties, some of the controverted questions connected with elementary education have been, for a time, at all events, disposed of, and that it will reappear with some of its revolutionary provisions extended. A reform of secondary education, no doubt, will require great energy and some self-sacrifice on the part of many. Probably also it may require some expenditure of money. I do not see why it should require any large call upon either Imperial or local resources. The large majority of secondary schools are now in private hands, and I know no reason why they should not continue to remain so, provided the local authorities are able to secure some guarantee of their efficiency. Secondary schools, such as they might be when reformed, would very soon furnish the technical classes, such as those you are establishing here, and increase the number of students qualified, as they cannot be now, to take advantage of those courses for their own benefit, and for the benefit of the community in which they exist. I hope that, although I have devoted my remarks almost exclusively to one topic—the necessity for improving the scientific and commercial education of our people—you do not imagine for a moment that I feel indifferent to the higher aspect of education which concerns the training and the character of the students. That is the work, however, rather of the school and for the schoolmaster, than of the science class or scientific teacher. The two need not conflict together, nor exclude each other. I know that the highest province of education is to raise the character of the student, and to make him not only an accomplished workman, but a good citizen. Do not suppose for a moment that those who, like myself, are merely interested in the promotion of technical education are indifferent to the higher side of the question; but it is because of the urgent necessity which we feel exists at the present moment to cultivate more than we have hitherto done the study of certain sciences and certain arts which are ultimately connected with the industrial training and prosperity of the people, that I on this, as on other occasions, have ventured to urge the sub'ect most strongly upon you.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. B. Peace, of Emmanuel College, has been appointed Demonstrator of Mechanism and Applied Mechanics, in the place of Mr. Dunkerley, resigned. Mr. H. Higgins, of King's College, has been re-appointed Demonstrator of Anatomy.

Prof. Bradbury has been re-appointed Assessor to the Regius Professor of Physic.

Mr. A. Munro (Queens') and Mr. Lay (St. Catharine's) have been appointed Moderators, and Mr. Macdonald (Clare), with Mr. Bennett (Emmanuel), Examiners, for the Mathematical Tripos 1898. Sir R. S. Ball has been appointed an Elector to the Isaac Newton Studentships.

Mr. W. G. Fraser, Senior Wrangler 1896, has been elected to a Fellowship at Queens' College. At Trinity College Mr. W. Morley Fletcher, First-class Natural Sciences Tripos 1894-95, and Mr. F. W. Lawrence, bracketed fourth Wrangler 1894, bracketed second Smith's Prizeman 1896, have been elected to Fellowships.

AT the opening of the session of the Royal College of Science on Wednesday, October 6, Prof. Roberts-Austen, C.B., D.C.L., delivered an address and distributed the prizes. He said that in this memorable year they would remember that the part taken by His Royal Highness the Prince Consort in establishing the School of Mines, out of which the Royal College of Science had grown, made the students participants in the beneficent care which Her Majesty the Queen had ever taken to promote the advancement of science and the industrial progress of her people. At the opening ceremony, on May 12, 1851, at the museum in Jermyn-street, where the School of Mines found a home, the Prince Consort had used the following words :—"I rejoice in the proof thus afforded of the general and still increasing interest taken in scientific pursuits, while science herself, by the subdivision into the various and distinct fields of her study, aims daily more and more at the attainment of useful and practical results. In this view it is impossible to estimate too highly the advantages to be derived from an institution like this, intended to direct the researches of science and to apply their results to the development of the immense mineral riches granted by the bounty of Providence to our isles and their numerous colonial dependencies." Prof. Austen said that the last words he had quoted, struck a note which was singularly tuneful and harmonious in this year when the bonds which join the mother country to her possessions had been so materially strengthened. It might fairly be claimed that the Empire had derived advantages from the establishment of the Royal School of Mines, and from the Royal College of Science. Having taken the Prince Consort's words as his text, Prof. Austen passed in review the position of technical teaching in the fifties, and indicated the nature of the work done by the distinguished body of men, including Playfair, Hofmann, Huxley, Tyndall, Percy, Warrington Smyth, and others, who had gathered round Sir Henry de la Beche, and he showed that the great success of the students in all parts of the world had been attained by recognising that the main duty of the professors had been, not to train specialists but to give men such all-round training as should enable them to deal successfully with any problems they might encounter in life. He then spoke of the great importance to students of general culture, pointing out that it was not without reason that the designer of the Jermyn Street Museum had placed a statue of Athena in a prominent position in the lecture theatre, for Mr. Ruskin had said that the myths which had gathered round the name of Athena pointed to her as "the directress of human passion, resolution, labour, and of practically useful art. She does not make men learned, but prudent and subtle; she does not teach them to make their work beautiful, but to make it right." Prof. Austen said that the students' work would never be right if they neglect the treasures of thought which come to us from antiquity. He urged them day by day to devote a few moments to the effort to really understand some marvel of the fifteenth century construction, by Da Vinci or by others who designed it at a time before the professions of engineer and architect were divided. Or they might examine some fragment of Japanese art metal work which in itself epitomised an advanced knowledge of metallurgy. If they used the museum in this way they would find that they were insensibly widening their intellectual field, and, at the same time, cultivating it with success.

THE new University Hall at Bangor, for women students of the University College of North Wales, was formally opened on Saturday last by Miss Helen Gladstone. Mr. Acland delivered an address on "Secondary Education in England and Wales."

AFTER an examination by the Agricultural Department of the Reading University Extension College, Mr. J. C. Fryer has been elected to the Senior Agricultural Scholarship given by the County Council. The Scholarship is of the annual value of 30*l.* (which may be increased at the discretion of the sub-committee to 50*l.*) per annum for two years, and is tenable at the Reading University Extension College.

THE Committee for the establishment of University Fellowships in the University of Wales have just presented their report to the Senate. The proposed Fellowships are to be confined to graduates of the University who are in the active pursuit of original investigation, and in residence at some constituent college or other seat of learning. They are to be tenable for two years, with possible renewal for a third year in cases of exceptional merit. It is proposed that the Fellowships should not be tenable concurrently with other similar endowments or paid appointments, as the Fellowships contemplated are to be of sufficient value to enable the holders to devote their whole time to research.

As the result of the past session's work students of the Engineering Department of University College, Liverpool, have gained the following successes :—Mr. W. H. Riddlesworth, holding a County Council Scholarship, succeeded in gaining the University Scholarship in open competition, which is the blue ribbon of the University in this subject. Mr. Riddlesworth has since been appointed private assistant to Dr. Francis Elgar, Manager Director of the Fairfield Engineering and Shipbuilding Company, Limited. Mr. E. Brown, holding a Ranger Scholarship, has been awarded the Sir David Gamble Scholarship for the purpose of prosecuting a research and continuing his studies in electrotechnics. Mr. P. S. Couldrey and Mr. C. H. Stewart, holders of City and County Scholarships respectively, have been awarded National Scholarships. Mr. E. J. Kipps, holding a Derby Exhibition from the Bootle Technical School, succeeded in securing the second place in the list of Whitworth Exhibitions. Mr. R. Nelson, the Sir Edward Harland Scholar, also obtaining a Whitworth Exhibition. Mr. T. H. Phillips, the holder of the Sir Richard Moon Scholarship from Crewe, has been awarded a Royal Exhibition in connection with the Science and Art Department examinations. Mr. W. L. Brown, after completing a lengthy research upon the Elasticity and properties of cement in connection with his University Research Scholarship, which has been accepted by the Institution of Civil Engineers, has been appointed by Sir Benjamin Baker to a position on the Central London Railway. Mr. J. T. Farmer, who was awarded an 1851 Exhibition Scholarship, after completing a research at Montreal on the action of jets of water, which was published by the Royal Society of Canada, has been the recipient of the honorary degree of M.Sc. of the Montreal University.

THE recent munificent gifts to Owens College, Manchester, were briefly mentioned in last week's NATURE. A full report of the meeting of the Court of Governors of the College at which the announcements of the donations were made, appeared in the *Manchester Guardian* of Wednesday, October 6, from which we reprint the resolutions of thanks passed by the Court. No apology is needed in referring again to gifts so liberal as those which Owens College has just received. The following are the resolutions which were adopted by the Court :—(1) "That the Court has heard with the greatest satisfaction and pleasure of the magnificent offer by Mr. Christie of a sum not less than 50,000*l.*, being the third at his disposal of the balance of the estate of the late Sir Joseph Whitworth, for the erection of a College hall and the completion, so far as the amount available will extend, of the College buildings; that the Court desires to express to Mr. Christie its sincere thanks for his splendid gift, which will meet a most important and long-felt need, and, besides adding to the outward importance and dignity of the College, greatly promote the cohesion of its inner life; that the Court requests the Council to provide for the association of the late Sir Joseph Whitworth's name with the proposed new buildings, in accordance with Mr. Christie's desire; and that the Court recognises with the deepest pleasure the proof furnished by Mr. Christie's present magnificent offer, as well as by his former gift of the buildings of the Christie

Library, of the deep personal interest taken by him in the progress of the College as a place of higher education and learning." (2) "That the Court accepts with great pleasure the munificent offers of two friends of the College of the sums of 10,000*l*. for the erection, and of 5000*l*. towards the maintenance, of suitable buildings for the physical laboratory, and requests the Principal to convey to them its sincere thanks for their wise and opportune generosity, which will enable the College to advance and develop a scientific teaching and research of the highest public importance and utility." (3) "That the Court accepts with great pleasure the generous and useful gift of Mr. Edward Holt to the College, and desires the Treasurer to express their best thanks to him. The Court also hopes that the Council will take steps to associate the name of Mr. Holt in some permanent manner with the new gymnasium."

SEVERAL of the London polytechnics have commenced the present session with some new developments in their day work. The Battersea Polytechnic is inaugurating day courses in technological chemistry, specially adapted to persons engaged in those industries for which a knowledge of chemistry is useful. The South-west London Polytechnic is not only developing its day engineering courses, but is also providing special facilities for students who wish to enter for the examinations of London University, and is starting a day department for women, in which opportunities will be given to pursue advanced studies in art, science, and languages. The East London Technical College, People's Palace, is further developing the day courses which were commenced last year. Courses in physics and electrical engineering are now given, as well as in chemistry and mechanical engineering, while facilities are offered to students to study for the various subjects of the London B.Sc. examinations. The Borough Polytechnic, besides adding considerably to its provision of scientific and technical instruction for artisans, has opened a technical day school for boys, which is specially designed to fit its pupils for entering on industrial life.

SCIENTIFIC SERIALS.

American Journal of Science, September. — Principal characters of the Protoceratidæ, by O. C. Marsh. The genus *Protoceras*, described by the author in 1891, from the Miocene of South Dakota, is now known to include some of the most interesting extinct mammals yet discovered. It likewise represents a distinct family, and thus deserves careful investigation and description. Before this discovery, no horned artiodactyles were known to have lived during Miocene time, and Protoceras is thus the earliest one described. The type specimen, moreover, had a pair of horn-cores on the parietals, and not on the frontals, as in modern forms of this group. The animal was apparently a true ruminant, nearly as large as a sheep, but of more delicate proportions. Another notable feature is the very large, open nasal cavity. This peculiar feature is of even greater importance than the horn-cores, and indicates clearly in the living animal a long flexible nose, if not a true proboscis. The paper is illustrated by a series of admirable plates.—The theory of singing flames, by H. V. Gill. If a singing flame is produced by inserting a burning gas jet into a tube, the pressure during a condensation forces the burning gas back into the nozzle of the jet. This can be made evident by observing the image of the flame in a rotating mirror, when a small flame is seen below the level of the nozzle, corresponding to the gaps in the main flame. —Oscillatory discharge of a large accumulator, by J. Trowbridge. The discharge from a large number of Planté cells is characterised by a sibilant flame which, by quickly separating the spark terminals, can be drawn out to a length of several feet. It closely resembles the light produced by passing an electric spark through lypocodium powder. When a photograph of this flaming discharge is examined, it is seen to have an intensely bright spark as a nucleus. By using an arrangement to blow out the flame, it was found possible to examine the spark by means of a revolving mirror. The photographs then showed five or six distinct oscillations. The author concludes that a cell may be regarded as a leaky condenser, and that its discharge is always essentially oscillatory.—Electric discharges in air, by the same author. The voltaic arc is a kind of flaming discharge as above described. Its resistance may be studied by the damping method. The author fed an arc light by a continuous current and by a condenser discharge, and found the resistance to be 0·8 ohms, which was independent of the length of the arc.—On *Pithecanthropus erectus*, by L. Manouvrier. The degree of fossilisation of the Trinil remains is such that the femur attains the weight of 1 kilogram, whereas prehistoric femurs of the same size do not exceed 350 grams. The important fact established by Dubois is that the craniological inferiority of human races increases with their antiquity. The known anthropoid genus to which the intermediate Pithecanthropus is most closely allied is the Gibbon (*Hylobates*). If the Pithecanthropus was a simple precursor of man, it was superior enough to the other animals to survive unless the human species hastened to annihilate this dangerous competitor. If it was an ancestor, its species lives yet in its human descendants.

Wiedemann's Annalen der Physik und Chemie, No. 9.—Action at a distance, by P. Drude. Action at a distance may be defined as a relation between two bodies such that the energy of the system depends not only upon their velocities, but also upon their mutual position. Contact action may take place by impact or through the intermediary of an elastic solid or a fluid, compressible or incompressible. Gravitation has not yet been reduced to a contact action, owing chiefly to the fact that its velocity of propagation through space has not yet been ascertained. According to Laplace, this velocity must be at least ten million times that of light.—Grey and red incandescence, by O. Lummer. Draper's assertion that all bodies begin to glow at the same temperature has been disproved by H. F. Weber and Emden, who showed that the first indication of a grey misty light occurs at temperatures ranging from 403° (German silver) to 423° (gold). The grey glow appears to fluctuate and flit about, but the image becomes fixed as soon as the red glow sets in. This may be explained by the constitution of the eye. The rods perceive the grey glow. The fovea centralis contains no rods, and hence the light is not seen if looked at direct. The cones, on the other hand, are the instruments of colour perception. They alone line the fovea centralis, and hence the red light is seen in its proper place. At a sufficiently feeble intensity the solar spectrum appears colourless along its entire length.—Glow on insulated conductors in a high-frequency field, by H. Ebert and E. Wiedemann. The authors place a wire or rod in a bulb or cylinder placed between the terminal condenser plates of a Lecher wire system, so that it hangs parallel to the axis of the condenser. A slight exhaustion suffices to produce a blue glow against both ends of the rod on the glass surface, which spreads out in all directions, and shows forms resembling Lichtenberg's figures. As exhaustion proceeds, the glow extends over the surface of the rod, and forms a bridge across the middle. The occurrence of this bridge is retarded by making the rod thicker, or using several wires, or substituting a tube for the rod.—Discharge inside a wire gauze box, by the same authors. If a cylindrical box of wire gauze is placed inside an exhausted tube, the glow of the gas is observed to penetrate inside the gauze, especially if the box is short.—Method of making lines on glass visible as light on a dark ground, by F. F. Martens. If a glass plate is illuminated through its end surfaces, no light penetrates through the large surfaces owing to total reflection. But if lines are etched into them or cut with a diamond, they appear bright on a dark ground.—Electric viscosity of insulators, by G. Quincke. The logarithmic decrement of a glass sphere suspended from the arm of a balance in ether is increased from 0·0210 to 0·0608 in a field produced by 2000 volts. The difference may be termed the electric viscosity.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 4.—M. A. Chatin in the chair.—On ancient glass mirrors backed with metal, by M. Berthelot. A description of some mirrors, of Gallo-Roman origin, dating from the third or fourth century. The metallic backing consists of lead, which would appear to have been applied in a molten state to the glass.—On the number and symmetry of the fibrovascular bundles of the petiole, in the measurement and classification of plants, by M. A. Chatin.—Observations on the sun, made at the Observatory of Lyons with the Brunner equatorial during the second quarter of 1897, by M. J. Guillaume. The results are summarised in three tables, showing the sunspots, their distribution in latitude, and the distribution of the faculæ in latitude.—Orthogonal systems for the derivatives of the θ-functions of two arguments, by M. E.

Jahnke.—On the differential linear congruences, by M. Alf. Guldberg.—A new method of testing metals, by M. Ch. Frémont. The size of the test pieces employed is much reduced (20 mm. × 10 mm. × 8 mm.), and the resulting deformations enlarged ten times by photography. Methods are given for measuring the tenacity, ductibility, fragility, and homogeneity of the sample with sufficient accuracy for practical purposes. —Study of the normal variation of the earth's electric field with height, in the upper regions of the atmosphere, by M. G. Le Cadet. The results obtained show that the intensity of the electric field of the atmosphere diminishes when the height above the surface of the earth is increased.—On the fogging of the negative in radiography, by M. V. Chabaud.—On the solubility of liquids, by MM. A. Aignan and E. Dugas. A criticism of the work of Alexejew on the same subject.—Action of gravity on the growth of the lower fungi, by M. Julien Ray. The action of gravity is to retard the growth. The experiments were carried out upon cultures of *Sterigmatocystis alba*, some of which were at rest, and others moving uniformly in a vertical plane.

NEW SOUTH WALES.

Linnean Society, August 25.—Prof. J. T. Wilson, President, in the chair.—Descriptions of Australian Micro-Lepidoptera; Part xvii., *Elachistidæ*, by E. Meyrick. The number of species recorded in this paper was 254, referable to thirty-seven genera. Nearly the whole of the species are new to science.—Note on the occurrence of sponge remains in the Lower Silurian of New South Wales, by W. S. Dun. Until last year fossiliferous rocks of Ordovician age were not known to occur within the geographical boundaries of New South Wales. A species of *Protospongia*, associated with graptolites in a bluish slate, is recorded from Stockyard Creek, County of Wellesley, N.S.W. The specimens, which are pyritised and show no great amount of detail, were collected by Mr. J. E. Carne, of the Department of Mines. The Wellesley beds are probably of the same age as those of the Castlemaine and Bendigo districts of Victoria, certain fossils from which have been reported upon by Mr. T. S. Hall.—Descriptions of two new species of *Pultenæa*, by R. T. Baker. Mr. Baker exhibited, on behalf of Mr. C. E. Finckh, of the Technological Museum, a specimen of a comparatively rare fish, *Moncentris japonicus*, Houtt., caught by a fisherman at Newcastle. In regard to this fish, Mr. Ogilby pointed out the presence of luminous discs, which he believed were of use as traps; he also remarked that no articulation of the scales so as to form "a coat of mail" existed in Australian specimens, such as is attributed to *Monocentris japonicus*. The presence of two separate dorsal fins removes this genus from the *Berycidæ*, and its nearest ally is the rare deep-sea *Anomalops*, with which it agrees also in the presence of luminous glands and of membranous interspaces between the bones of the cranium.—Mr. Brazier sent for exhibition six specimens of *Helix vermiculata*, Müller, obtained alive by him on July 13, 1897, on the buffalo-grass in the Waverley Cemetery. This is the first Australian record of this introduced European species, whose home is France, Spain, Italy, &c.—Mr. Hedley exhibited, by permission of the Curator of the Australian Museum, a specimen of *Cancellaria granosa*, Sowerby, taken from the stomach of a schnapper hooked nine miles east of Wollongong, N.S.W., in 30-40 fathoms. An interest attached to this specimen is that though the species is well known in Tasmania, Victoria, and South Australia, it has not apparently been recorded previously from the coast of N.S.W. Mr. Hedley remarked that an exploration of the deep, cold-water current that lay off the coast would result in adding many other southern forms to our known fauna. A previous instance of such is the record [P.L.S.N.S.W. (2) iv. p. 749] of *Crassatella kingicola*, Lamk., a characteristically Tasmanian species trawled in 17 fathoms off Merimbula, N.S.W. If fishermen could be induced to search the stomachs of fishes, a mass of valuable data would soon accumulate.—Mr. Norman Hardy read a note on, and exhibited specimens of, feathered arrows from the island of Espiritu Santo, New Hebrides. It has long been held as an ethnological axiom that no arrow from any Pacific island was feathered. This rule is now shown to have its exception, and for the first time the locality whence these feathered arrows come is now published.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section) part 2, 1897, contains the following memoirs communicated to the Society:—

May 15.—George Landsberg: The algebra of the Riemann-Roch theorem. O. Mügge: Translations and other related phenomena in crystals. J. R. Schütz: The principle of the absolute conservation of energy.

May 29.—J. Orth: Researches carried out in the Pathological Institute at Göttingen.

June 19.—A. Hurwitz: Linear forms with integral variables. L. Krüger: A theorem in the combination of observations.

July 3.—E. Ehlers: East African Polychæte worms. C. Fromme: On magnetic hysteresis. P. Gordan: Hermite's reciprocity-theorem.

July 17.—W. Voigt: Determination of relative thermal conductivity by the isothermal method.

July 31.—F. Klein: A new manuscript relating to Bernhard Riemann. A. Wiman: Note on the symmetrical and alternating interchange-groups of n things. H. Minkowski: General theorems on convex polyhedra.

BOOKS RECEIVED.

BOOKS.—Memory and its Cultivation: Dr. F. W. Edridge-Green (K. Paul).—Elements of Human Physiology: Dr. E. H. Starling, 3rd edition (Churchill).—Electricity in the Service of Man: Dr. R. Wormell, revised and enlarged by Dr. A. M. Walmsley (Cassell).—Botanical Observations on the Azores: W. Trelease.—Royal Gardens, Kew, Bulletin of Miscellaneous Information, 1896 (Eyre).—A Question of the Water and of the Land: Dante Alighieri, translated by C. H. Bromby (Nutt).—The Dwelling-House: Dr. G. V. Poore (Longmans).—Lumen: C. Flammarion, translated (Heinemann).—15 Lezioni Sperimentali su la Luce: A. Garbasso (Milano).—Year-Book of the U.S. Department of Agriculture, 1896 (Washington).—The Principles of Chemistry, 2 Vols.: D. Mendeléeff, translated by G. Kamensky, edited by T. A. Lawson (Longmans).—The Machinery of the Universe: Prof. A. E. Dolbear (S.P.C.K.).—Sleep: its Physiology, Pathology, Hygiene, and Psychology (Scott).—A Memoir of Wm. Pengelly, F.R.S.: edited by his daughter, Hester Pengelly (Murray).—Missouri Botanical Garden, 8th Annual Report (St. Louis, Mo.).—Œuvres Complètes de Christian Huygens, tome septième (La Haye, Nijhoff).—Elementary Manual of Magnetism and Electricity: Prof. A. Jamieson, 4th edition (Griffin).—The Principles of Alternate-Current Working: A. Hay (Biggs)—A Text-Book of Applied Mechanics: Prof. A. Jamieson, Vol. 2 (Griffin).—The Works of Archimedes: edited in modern notation, with introductory chapters, by Dr. T. L. Heath (Cambridge University Press).—Theory of Groups of Finite Order: Prof. W. Burnside (Cambridge University Press)—The Röntgen Rays in Medical Work: Dr. D. Walsh (Baillière).—Darwin and after Darwin: Dr. G. J. Romanes, III. (Longmans).—John Hunter: S. Paget (Unwin).—Les Fonds Electriques et leurs Applications: A. Minet (Paris. Gauthier-Villars).—Die Meteoriten in Sammlungen und ihre Literatur: Dr. E. A. Wülfing (Tübingen, Laupp).—Luce e Raggi Röntgen: Prof. R. Ferrini (Milano, Hoepli).

CONTENTS.

THURSDAY, OCTOBER 21, 1897.

GEOLOGY FROM AN AMERICAN POINT OF VIEW.

An Introduction to Geology. By William B. Scott, Blair Professor of Geology and Palæontology in Princeton University. Pp. xxvii + 573. 8vo. (New York: The Macmillan Company, 1897.)

IT is always well to keep in touch with the methods and conclusions of workers in other countries; and in a general way this can only be done by text-books. In this respect the present work will be found of considerable service to British students of geology. It is intended especially for American students, and has been written both for those who desire to pursue the subject exhaustively, and for those who seek only to learn the principal results of the science. To satisfy the needs of these different classes is a task that it would be impossible fully to attain in any work, for the details required by some would be apt to repel others. Nevertheless, the author has well succeeded in his main endeavours.

We may pass over that usual stumbling-block to the general reader, the chapter on rock-forming minerals, which, as the author says, "is intended rather for reference than for actual learning." It might perhaps have found place in the appendix, alongside the table of European strata and the classification of animals and plants. It is essential, however, that something be said on the subject, and the author treats it concisely and without needless detail. He then proceeds to give a full and very interesting account of the changes which are now in progress on the surface of the earth, admirably illustrated with photographic reproductions, and embodying the results of the most recent researches.

The igneous and stratified rocks, their structure and dislocations, are next described in a similar manner, with photographic and diagrammatic illustrations; and of much interest to British students is the account of various kinds of folds and displacements to which American geologists in particular have assigned special names.

In the part relating to physiographical geology again we have very useful illustrations of many phenomena and of terms now largely used in geological literature, but not as yet so clearly explained in other text-books. The chapter on the adjustment of rivers, dealing with antecedent and superimposed rivers and subsequent streams, as explained by Prof. W. M. Davis, cannot fail to be of service. The treatment of the many subjects causes here and there some repetition, as in the case of soil (pp. 76, 124, and 217), and a little condensation might be made in a future edition in reference to this and a few other matters.

The least satisfactory part of this volume is that dealing with stratigraphical palæontology. Something should have been said about geological zones and of their importance in correlating strata belonging to distant regions. As it is, we have to be content with a lithological account of the leading formations developed in America, and of the extent of these in other parts of the world; we are told something about their method of formation, but as regards the life-history we have simply a statement of the genera of Ordovician or Devonian, as the case may be, and figures of some of the characteristic American species. There is but a meagre hint that rocks of Devonian and Old Red Sandstone type have been recognised in America. We are informed that along the eastern shore of the Chemung Sea (Upper Devonian), there was accumulated an immensely thick sandstone (7500 feet), which was formerly supposed to represent a distinct series, and called the Catskill. Again, it is stated that "the so-called Catskill of New York is very like the Old Red, and contains similar fossils." Surely it would have been of interest to state that the rocks of this type in America contain *Holoptychius* and *Bothriolepis*. The lack of special palæontological information is felt when we read that "in North America the passage from Silurian to the Devonian is very gradual, the former drawing to its close without disturbance; and there is still some difference of view as to just where the line between the two systems should be drawn." Moreover, "in many parts of North America the Devonian was followed so quietly by the Carboniferous, that it is very difficult to draw the line between them; but in other regions notable geographical changes occurred." These indications of a gradual passage are so similar to those met with in this country, that a few further materials for comparison would have been very welcome.

The author's general scheme of classification is a happy one. He uses the term Archæan to include the most ancient rocks, often spoken of as the "basement or basal complex." Between this Archæan complex and the Cambrian comes the Algonkian period, termed Eozoic, though at present the indications of former life are mainly inferred from the presence of limestones and graphite. Above the Cambrian we have the Ordovican, Silurian, and other periods. The Permian is grouped with the Palæozoic, as it is on the whole distinctly connected with it, although "it has several features which mark it out as transitional to the Mesozoic." In following through the account of the various formations we find many matters of considerable interest, and we are also introduced to the various terms applied to subdivisions of the geological series in North America. Among these the "Clear Fork Beds" of the Permian and the "Goodnight Stage" of the Pliocene, sound somewhat strange when compared with British terms.

There was a time when Eskers and Kames were considered to be synonymous. American geologists have for some time recognised a difference—*Kames* being considered as "hillocks or short ridges of stratified drift, formed by the deposition of materials from subglacial streams as they escape from under the margin of the ice," while *Eskers* or *Åsar* are "long, winding ridges of sand and gravel," which follow the general direction of the moving ice, and may have been laid down in channels or tunnels in the ice. These and other explanations are interesting and useful. In some instances the references are far too meagre, as in the case of Cherts, where their organic origin through sponge-spicula and radiolaria is not sufficiently indicated.

The numerous photographic illustrations are very beautiful and instructive; indeed, they lend additional

charm to this pleasantly written book. The diagrammatic figures are also well executed; the only one which we notice as not clear is that of a fissure-spring (Fig. 31). A spring issuing from the spot indicated would surely be an overflow from the inclined beds of conglomerate and sandstone. A diagram showing an artesian well might be added in a future edition.

Students and teachers should bear in mind the advice given by the author, to look not too impatiently for definite and final opinions on vexed questions. Evidence must be weighed and judgment often suspended. As he quaintly puts it, "An open-minded hospitality for new facts is essential to intellectual advance."

H. B. W.

AN ANATOMY OF THE HORSE.

Topographische-Anatomie des Pferdes. By Dr. W. Ellenberger and Dr. H. Baum, of the Veterinary School, Dresden. 3 vols. Pp. 951. (Berlin: Parey, 1897.)

THE first volume of this work contains 271 pages, and appeared in 1894; it comprises a description of the anterior and posterior limbs, with some beautifully executed plates, some few in colours. The nomenclature is, for the most part, that used in human and comparative anatomy, so that this book, unlike many other veterinary works on this subject, may be read and appreciated by all who have a knowledge of human anatomy, and who are interested in the anatomy of the horse from a comparative point of view.

The muscles, blood-vessels, and nerves are well described and depicted in the numerous and excellent illustrations. The names used are generally those of their homologues in the human subject: it may be noticed that the triceps in the fore limb is called a coneus. In the hind limb the rudimentary soleus is delineated, as is also the considerably developed plantaris. The strongly developed internal obturator, which in the horse is in two portions, one part arising in the usual place, the other from the internal surface of the ilium—this latter being often wrongly called pyriformis in this country—is here correctly described and named. A prominent feature in this work is the numerous sectional diagrams (several in each segment of the limbs being given), which the student will find most helpful in assisting him to understand the correct relations of the various structures. The contents of the hoof is dismissed in about ten pages, and the subject well, though not too verbosely, treated; the text being illustrated by two transverse sections and one side view.

The second volume, which also appeared in 1894, consists of about 350 pages of well-written text. It treats of the head and neck, and contains sixty-seven diagrams, among which are many transverse and longitudinal sections, as well as some good dissections. The eye, ear, and brain are thoroughly described, the text everywhere suitably illustrated.

The third volume, which only appeared early this year, contains 330 pages and sixty-six illustrations and diagrams; it commences with the chest and its relations to the fixed portions of the fore limbs, and the text is illustrated by a series of transverse sections. The thoracic viscera are next described, and their relations, both to the surface and to the great vessels and nerves within the cavity, are well described and illustrated by finely-coloured plates. The abdominal and pelvic cavities are treated on similar lines; the arrangement of the peritoneum and its relations to the contained viscera is shown by many transverse and longitudinal sections, and the volume is concluded by eight full-page drawings which illustrate in a diagrammetic manner the right and left aspects of the trunk, showing the viscera in their relations to the bones and soft parts. The other plates illustrate the intestinal relations to the abdominal floor, the internal abdominal rings, and contents, as seen from the front; and, finally, a front and side view of the horse with surface markings of the various muscles and bony prominences as seen through the skin.

We have no hesitation in recommending this work to all requiring a precise and accurate treatise on the anatomy of the horse, and we feel sure that it will be widely read by all veterinary students possessing a knowledge of the German language; and it will be found useful to the English student, particularly for its numerous illustrations and diagrams, which, with some knowledge of the subject, can be easily understood without more than an ordinary acquaintance with the language.

OUR BOOK SHELF.

First Stage Physiography. By A. M. Davies, A.R.C.S., B.Sc., F.G.S. Pp. viii + 238. (London: W. B. Clive 1897.)

As the author of this book points out, the scope of physiography has changed very considerably since the word was first introduced. Always intended as an introductory course of science, it has been modified from time to time with the view of better adapting it to the needs of the system of national examinations controlled by the Department of Science and Art. Last year the changes were very considerable, and new text-books of the type before us may be regarded as a natural consequence. The first six chapters deal with the subject-matter of Section I. of the revised syllabus, on which a separate examination is now held. While apparently not intended for the use of students taking this section as a distinct subject, this portion of the book may meet the needs of such, providing the detailed syllabus itself is also utilised, and the necessary experiments carefully performed. It is, however, sufficiently comprehensive for students taking the ordinary elementary stage, and has the merit, in a subject where so much ground has to be covered, of conciseness without sacrifice of clearness. The treatment of the other well-known branches of the subject follows closely the lines of the official syllabus. Though showing but few new features, the book appears likely to meet the requirements of both teachers and students.

La Plaque Photographique. Par R. Colson. Pp. 165 + iv. (Paris: Georges Carré et C. Naud, 1897.)

GREAT is the number of photographers, but how few are those who have any conception of the action of the rays of light on the photographic plate? Every one who dabbles in the "black art" should try to make himself or herself acquainted with some of the rudiments of this side of the subject, for a knowledge of principles helps not only to render the results more perfect, but to add an additional interest to the pursuit of this science.

The book which we have before us is suitable for those even not very advanced in the subject, and is well worth

reading. The author commences by bringing to the reader's notice the properties of the sensitive plate, the principles involved in its preparation and use, dealing further on with the several rays which influence it, namely chemical, light, electrical, mechanical, &c. The Röntgen rays are, of course, elaborately dealt with, and their action on the photographic plate, as far as is known, is discussed.

Another chapter is devoted to the old experiments of Niepce de Saint-Victor, which were made in 1857 with the object of investigating whether light could be stored up in bodies apart from the phenomena of phosphorescence and fluorescence: several interesting abstracts are here made from the originals. The succeeding chapter deals with the more recent experiments made on the above lines, while the subject of the last one consists of the precautions which must be taken in the preservation and employment of photographic plates.

Luce e Raggi Röntgen. By Oreste Murani. With a preface by Prof. R. Ferrini. Pp. x + 392. (Milan: Ulrico Hoepli, 1898.)

15 *Lezioni Sperimentali su la Luce.* By A. Garbasso. Pp. iv + 259. (Milan: Office of *L'Elettricità*, 1897).

PROF. MURANI'S volume upon light and Röntgen rays does credit to Italian science. It may be described as a work on light with special reference to Röntgen rays. The general phenomena of light—such as reflection, refraction, diffraction, decomposition, polarisation, &c., are first explained, and then the character of the electric discharge in rarefied gases and high-vacuum tubes are described. This naturally leads to Lenard's and Röntgen's investigations, and once launched in the sea of X-ray literature the author has no difficulty in finding material upon which to exercise his powers of composition. The work of English investigators is frequently referred to, and an attempt has been made to include the best of what has been done and thought in connection with Röntgen rays. The illustrations are fairly numerous (there are 157, and 15 plates), but they are no better than those published in other works on the same subject. As is common in continental publications, the book is published without an index.

Dr. Garbasso's book contains a number of experiments on light considered as an electro-magnetic phenomenon. It is a little volume from which teachers and demonstrators of physics may obtain information upon many experiments, and which gives readers of Italian an instructive view of electric oscillations. The first four chapters of the book are devoted to descriptions of the fundamental principles of electricity and magnetism, and the remainder is devoted to the work of various investigators of electric waves.

Waste and Repair in Modern Life. By Robson Roose, M.D., LL.D., F.R.C.P. Edin. Pp. 364. (London: John Murray, 1897.)

THE book before us consists of twelve essays which have already been published elsewhere, and are now brought up to date and collected, making a thickish book. The subject-matter of these essays is very various, the title of the book being apparently taken from the first two essays. Amongst others the following questions are considered:—The art of prolonging life; the alcohol question; fasting and its physiology; the London water supply, &c. The book cannot be regarded as a serious contribution to any of the subjects dealt with, and will hardly appeal either to the medical profession or to the readers of NATURE. It is, however, written in a chatty style, and that section of the public which is interested in the acquisition of medical superficialities will find it certainly readable, and probably instructive.

F. W. T.

Missouri Botanical Garden. Eighth Annual Report. Pp. 236. (St. Louis, Mo.: Published by the Board of Trustees of the Missouri Botanic Garden. London: W. Wesley and Son, 1897.)

THE scientific papers in this report of the Missouri Botanical Garden are as follows:—"The Mosses of the Azores" and "On some Mosses collected in Madeira by William Trelease in June 1896," by M. J. Cardot; and "Botanical Observations on the Azores" by the Director of the Garden, Mr. W. Trelease (see NATURE, p. 551). As there is a prospect that the sum at present available for the purposes of the Garden will be increased, the Director has drawn up a general plan for the extension and development of the institution, to bring it into full conformity with the intentions of its founder, Henry Shaw. One of the clauses in Mr. Shaw's will stated "that scientific investigations in Botany proper, in vegetable physiology, the diseases of plants, the study of the forms of vegetable life, and of animal life injurious to vegetation, experimental investigations in horticulture, arboriculture, &c., are to be promoted." This clause has never been lost sight of, and a number of scientific papers have been prepared by Mr. Trelease and his assistants. The new scheme provides further facilities for research work. "I hope," says the Director, "to live to see the income of the Garden so ample that it shall claim among its regular employees men recognised as the equal of any in the country, if not in the world, in horticulture, vegetable physiology, morphology, paleo-botany, phanerogams, pteridophytes, bryophytes, fungi, algæ, and lichens. Ultimately it is very possible that the money available for research work will admit of the employment in the same manner of an entomologist, and there is a possibility that in coming generations other branches of zoology may be represented." It is to be hoped, for the sake of scientific progress, that the plans which are at present only on paper will all be materialised in the near future.

Year-Book of the United States Department of Agriculture for 1896. Pp. 686. (Washington: Government Printing Office, 1897.)

THIS Year-Book is in many respects a unique publication. Consisting of a bound volume of more than six hundred pages, published annually at Government expense in an edition of half a million copies, and for free distribution, it is a standing testimony to the encouragement given to scientific agriculture in the United States. The first part of the volume contains a brief general report on the operations of the Department of Agriculture, but this only occupies fifty pages, the remaining portion being taken up with papers, by agricultural experts, discussing the result of investigations in agricultural science and farm practice. In imparting this information, technical language is avoided, so far as possible, in order that the papers may be easily understood by the class for whose interests they have been prepared. Among the subjects dealt with are: the extermination of noxious insects by bounties, the use of steam apparatus for spraying, influence of environment in the origination of plant varieties, potash and its function in agriculture, irrigation on the great plains, insect control in California, diseases of shade and ornamental trees, migration of weeds, agriculture education and research in Belgium, olive culture in the United States, and ambrosia beetles. Several of these papers have already been noticed in NATURE, having been received in the form of excerpts from the present volume.

Practical farmers in the United States, and students of agriculture and related sciences, should be grateful to the Government which so freely publishes information of the kind contained in this Year-Book.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

On the Meaning of Symbols in Applied Algebra.

ON reading the correspondence in NATURE (vol. lv.) on this subject, my sympathies were with the physicists as typified by the Professors Lodge; but I think that the mathematicians as typified by Messrs. Jackson and Cumming have a legitimate grievance.

The following statement is "abhorrent" to the mathematicians. The horizontal intensity of the earth's magnetic field at a certain point is

$$\cdot 200 \frac{\sqrt{\text{gm.}}}{\text{sec.} \sqrt{\text{cm.}}}$$
$$= \cdot 200 \frac{\sqrt{\cdot 00220 \text{ lb.}}}{(\text{min.} /60) \sqrt{\cdot 0328 \text{ ft.}}}$$
$$= 3 \cdot 11 \frac{\sqrt{\text{lb.}}}{\text{min.} \sqrt{\text{ft.}}}$$

The physicist attaches a definite-enough meaning to this statement, and to the result of this little piece of generalised arithmetic. This is that if an observer go through the well-known process of finding H with two different sets of instruments: (1) a balance with gramme weights, a clock counting in seconds, and a scale divided to centimetres; and (2) a balance with lb. weights, a clock counting in minutes, and a scale divided to feet; then if his results on reduction give H = ·200 in the first case, they will give H = 3·11 in the second.

The mathematician will not for a moment dispute this result, and he will not deny that precisely similar processes will always give correct results. But he is, nevertheless, inclined to take up the position that no meaning can be assigned to the combination $(\text{gm.})^{\frac{1}{2}} \text{ sec.}^{-1} (\text{cm.})^{-\frac{1}{2}}$. And his legitimate grievance is that nobody has placed these convenient processes on a general logical basis. (I believe this last is a fact.)

There is nothing illogical or mathematically immoral in the following simple assertions. In ordinary algebra there is no meaning attached to a length × another length, or to a length ÷ a time. We may, therefore, assert that a length × another length *shall mean* a certain area, viz. that of a rectangle, two of whose adjacent sides are the lengths; and a length ÷ a time *shall mean* the velocity of a body which covers the length in the time. We are at perfect liberty to make these definitions, even if it should turn out that the ordinary laws of algebra will not hold for the new kind of multiplication and division. But if, as it turns out is the case, those laws should hold, we have extended the meaning of algebraic results, which is a great gain; and we have provided ourselves with a new physical instrument of thought, which is a greater gain.

How to put all such mathematical processes, which the physicist is constantly employing, on one general logical basis? The following definitions hint a sketch of one way of proceeding.

In the definitions "number" will be taken to mean any real algebraic quantity—positive or negative, rational or irrational.

The algebraic definition of variation is applicable equally to numbers and to physical quantities. Let A and B be either two numbers or two physical quantities, possibly of different kinds. The ordinary algebraic definition of variation may be expressed thus:—A ∝ B if A depends on B in such a way that when B is multiplied by *any* number, A is multiplied by the same number. For instance, if the base of a triangle be given the area ∝ the altitude. The first of the following definitions includes the above as a particular case.

Definition 1. *$A \propto B^n$ if A depends on B in such a way that when B is multiplied by any number x, A is multiplied by x^n.* For instance,

$$\text{Edge of cube} \propto (\text{volume})^{\frac{1}{3}};$$

and in a race over a given course

$$\text{Runner's average velocity} \propto (\text{his time})^{-1}.$$

Definition 2. *If X is determined by, and depends in a specified manner on, the independent physical quantities (or numbers) A, B, C, . . ., in such a way that $X \propto A^a$ when B, C . . . are constant, and $X \propto B^b$ when A, C, . . . are constant, &c., then*

$$X = A^a B^b C^c \ldots$$

The words "in a specified manner" are important. For instance, an area can be made to depend on two independent lengths in an infinite variety of ways. The specified manner *might* be as follows:—The area X is the area of a triangle whose base is A and altitude B. Then according to the definition X = A B. But this is not the conventional specification. For that of course we must read "rectangle" for "triangle." Again an acceleration X may be made to depend in the way described in the definition on an independent length A and time B as follows:—X is the acceleration with which a body must move from rest to describe the length A in the time B. According to the definition we should then have $X = A B^{-2}$. But this again is not the conventional specification. For the latter we must read "X is half the acceleration," for "X is the acceleration."

With these definitions it is not hard to show (1) that *all the laws of ordinary algebra* which have any meaning under the new circumstances *are true*, and (2) that *all such laws are true generalisations of the ordinary laws* in that the latter are particular cases. ALEX. MCAULAY.

University of Tasmania, Hobart, June 19.

Dog Running on Two Legs.

THE following instance shows how easily and well a four-legged animal can adapt itself to run on two legs only.

Last July a beautiful black and white shepherd's dog, on the Downs farm, near here, was caught amongst the knives of a reaping machine. Both the legs on the dog's right side were dreadfully mangled, and the animal almost bled to death. The right hind leg was so torn that one long piece and several small pieces of bone dropped from the wound. The dog lay for some time senseless and practically bloodless and lifeless. The kind-hearted shepherd, however, to whom the dog belonged, would not allow it to be at once destroyed; he bound up its terrible wounds, put it carefully in a wheelbarrow, wheeled it home, and nursed it. After two or three weeks the animal had so far recovered as to be able to crawl and move about on its two left legs with a little assistance from its crushed right fore-leg.

This dog now lives with the shepherd at Dunstable, and runs backwards and forwards to Downs farm—a mile off—every day. The greater part of the journey is performed on the two legs of its left side, as the dog can do nothing whatever with its right hind-leg, and the right fore-leg is so damaged as to be only useful as a slight occasional prop. In starting to run, the dog quickly gets up, jerks his ruined right fore-leg over the left leg, balances itself on its two left legs only, and very rapidly hops off in the style of a large agile bird, both right legs hanging useless. With this strange mode of rapid progression it now attends to sheep exactly in the way of an ordinary uninjured dog. It is a most affectionate animal, and is now apparently full of life and health. When I went to see it this morning, it sprang up and happily bounded to me balanced on its two left legs. WORTHINGTON G. SMITH.

Dunstable.

Foraminifera in the Upper Cambrian of the Malverns.

IN the early part of this year, whilst engaged in researches in the *Sphærophthalmus* zone of the Upper Lingula Flag Series, Prof. Theodore Groom, of Cirencester, found a shaley limestone which, when examined superficially under a fairly high power, showed indications of Foraminifera. Dr. Groom had a thin section prepared from this rock, and detected in it undoubted remains of Foraminifera. This preparation, together with specimens of the rock, he has courteously placed in my hands for further investigation, the results of which will be embodied in an appendix to Dr. Groom's paper on these beds.

The Foraminifera, for the most part, belong to the genus *Spirillina*, which has hitherto never been found below Jurassic strata, and these organisms make up at least 20 per cent. of the bulk of some specimens of the rock. The other genera present appear to be *Lagena*, *Nodosaria* (*Dentalina*), *Marginulina*, and *Cristellaria*.

This occurrence of Foraminifera is of great interest, taking into consideration the age of the beds; for, so far as I am aware, excepting the occurrence of the remains recorded by Dr. Cayeux from Pre-Cambrian beds in Brittany, and the foraminiferal casts in the Lower Cambrian of the Baltic Provinces described by Ehrenberg, these are more ancient than those of the well-known discoveries of Brady, Blake, Ulrich, and others, in beds of Ordovician and Silurian ages. So well preserved are these Upper Cambrian Foraminifera that the finely perforate structure can be seen here and there, which leaves no doubt as to their position as members of the Hyaline group of the Foraminifera. FREDERICK CHAPMAN.

Acquired Immunity from Insect Stings.

IN connection with this subject (see NATURE, vol. lv. p. 533, *et alibi*), it may be interesting to quote the following passage from "An Account of a Journey to Leetakoo," performed by a Dutchman, named Truter, in 1801 (appended to Sir John Barrow's "Voyage to Cochin China" (London, 1806), wherein the passage occurs on p. 382): "It was remarked that . . . the sting of a scorpion, which to Europeans and colonists is always attended with dangerous consequences, . . . has no ill effect on this people [the Bosjesmans], which they endeavoured to explain by saying that while children being accustomed to be stung by these insects, the poison in time ceases to have any effect on them, as the small-pox-virus loses its action on a person who has had the disease." KUMAGUSU MINAKATA.

October 11.

A NEW CLASS OF ORGANIC ACIDS.

A RECENT paper by Prof. Claisen in *Liebig's Annalen* (297, 1-98) is interesting, not only because it is one of a series of valuable contributions which he has published during the last few years, but also because it contains important observations on the occurrence of strongly marked acidic properties in certain hydroxymethylene derivatives.

Ever since Lavoisier attributed to oxygen the *rôle* of "acidifying principle," attempts have been made to assign a similar function to particular atoms or groups; and at the present time we say, that a substance possessing the properties of an "acid" contains, in addition to hydrogen or hydroxyl, some so-called acid-forming or electronegative atom or group of atoms. Consequently when we meet with an organic substance having in any degree the characters of an acid, we immediately associate these properties with the presence of this or that "acidifying principle." We account for the readiness with which the phenolic hydrogen atom is displaced by alkalis by saying that the hydroxyl group is influenced by combination with the electro-negative or acid-forming phenyl radicle; and we say that the reason why the alkali derivatives of phenol are decomposed by carbonic acid, whilst those of the nitrophenols are not so decomposed, is because in the latter the acid character of the hydroxyl group is further enhanced by the presence in the molecule of the nitro-group.

Phenol (carbolic acid) and nitrophenol, however, we do not usually call "acids," and we cautiously speak of their metallic "derivatives" and not of their "salts" in order to avoid the use of terms which might be misleading. Similarly we speak of the metallic "derivatives" of nitromethane, of ethylic malonate, of ethylic acetoacetate, &c., but we do not call the parent substances "acids."

It appears, however, that the time has now come when we must admit a new class of substances, namely, the hydroxymethylene derivatives recently prepared by Prof. Claisen, to the distinction of being called "acids." The substances in question may all be referred to the type $\begin{matrix}R.CO\\R.CO\end{matrix}\!\!>C = CH.OH$, where R represents either an alkyl-group (CH_3—, C_2H_5—, &c.) or an alkyloxy-group (CH_3O—, C_2H_5O—, &c.), and they are described by Prof. Claisen as follows:—They are all strong monobasic acids. They can all be accurately estimated by titration with normal alkali in aqueous alcoholic solution. They dissolve freely, even in the cold, in aqueous solutions of alkali acetates, liberating acetic acid. The determination of the electrical conductivity gave a value for K greater than that obtained for acetic acid. Among substances composed of carbon, hydrogen, and oxygen only, and not containing a carboxyl-group, they are doubtless the first which approach the monocarboxylic acids (excepting formic acid) in strength, and even surpass some of them.

The acid character of these compounds may of course be accounted for in the usual way, and, as Prof. Claisen points out, the substances may be regarded as formic acid, O = CH.OH, in which the oxygen atom has been displaced by the group $\begin{matrix}R.CO\\R.CO\end{matrix}\!\!>C =$, which itself contains the two electronegative radicles $(R—CO—)_2$; nevertheless the possession of such strongly acidic properties by compounds of this kind is a fact of extraordinary interest and almost as disturbing to our preconceived ideas as was the discovery of an acid containing only nitrogen and hydrogen. F. STANLEY KIPPING.

DRAINAGE AND IRRIGATION WORKS IN MEXICO.

THE valley in which Mexico is situated is almost unrivalled for its beauty, and is encompassed on all sides by great mountain ranges clothed with cedars and pines. The land is extremely fertile, notwithstanding its elevated position of 7000 feet above the level of the sea. Although thus beautifully placed, and at such a great elevation, Mexico was considered one of the most unhealthy cities in the world, the death-rate amounting as high as 40 per thousand; the cause being the want of proper drainage. The valley forms an immense basin covering 2220 square miles, hemmed in with solid walls of rock, and having only two or three high passes out of it. The valley thus shut in formed at one time an inland sea, but owing to earthquakes and other causes the water gradually subsided until it became confined to six great lakes. Each of these lakes is fed by streams from the mountains, which in winter frequently cause the lakes to overflow and inundate the adjoining land. It was in the middle of this valley that the Aztecs founded their city of Tenochitlan, building their houses and temples on piles. Subsequently as the water lessened and the fear of inundation became less, the dwellings were placed on the water-logged ground.

This was the condition of the country when Cortez chose this site as the capital of New Spain. The old canals were filled up, the city was extended, and great walls built to keep out the water. The city, however, was subject to frequent inundation. In the seventeenth century, after a great flood, the water stood at the level of the second story of the houses for several years. Various attempts were made to obtain an outlet for the water, and in the seventeenth century a canal 10 miles in length, with a tunnel 10 miles long through the mountains, was constructed, in which 15,000 Indians were engaged, which partially answered the purpose for which it was intended. The tunnel subsequently became blocked after an earthquake by the sides falling in, owing to their having been only supported by timber.

The tunnel having become useless, it was determined by the Spaniards to open it out, but 150 years were allowed to elapse before this was finally accomplished in 1789. The excavation is 14 miles long, and measures about 300 feet in width and 180 feet in depth. Through this cut, which has assumed the appearance of a natural gorge, the Mexican Central Railway now runs. During the time the work was in hand the locality became depopulated, owing to the insatiable demands for labourers, and finally these had to be imported from

other places. This cutting, although it provided an outlet for the flood water, gave only partial relief to the drainage of the city, the general level of which is about 6½ feet above the surface of the water in Lake Texcoco, into which the main outfall discharges; while the water in the other lake varies from 4 to 13 feet above the pavement of the streets. When the level of the water is raised in the lake, it is backed up the sewers into the city, and the whole surface of the ground has become saturated with sewage.

For a very long period, schemes were under consideration for effectually draining the city, and works were begun from time to time, and then suspended, and it was not until 1849 that a definite plan was determined on. The works recently completed were commenced in 1866, but owing to the revolution were stopped, and remained in abeyance until 1885. The City Council then contracted a loan for 2,400,000*l.*, which, however, was expended without finishing the work, and the Mexican Government had to appropriate further funds for the purpose. The contract was first let to an American firm, but was subsequently taken out of their hands and completed by Messrs. Pearson and Son, the well-known English contractors.

The works now carried out consist of a canal starting at the city gates, and running 22 miles to the mountain, through which it passes by means of a tunnel 6¼ miles in length and 14 feet in diameter, driven principally through sandstone, and at the highest point being 300 feet below the surface. The canal varies in depth from 17 feet to 65 feet, and is 20 feet wide at the bottom.

This canal will take the storm water and sewage of the City of Mexico, and discharge it into the Valley at Tequixquiac. . It will also control the height of the water in the lakes, but not drain them. The cutting of the canal involved a considerable amount of structural work where it crossed the railways and high roads, and in providing for the drainage of the district through which it passes.

While the work above described consists of works for "unwatering," another project of great magnitude recently carried out is for rendering land fertile by bringing water on to it. There are evidences to show that irrigation has been practised in Central America before the time of historical record. When the Spanish invasion of Mexico took place, the Indian inhabitants were dependent on irrigation for raising the crops of grain and cotton which they cultivated, and Mexican landowners have continued to follow in many cases the methods of their predecessors, but in others have brought to bear on their operations the principles of engineering science, and have applied them to very large tracts of land which otherwise would have remained practically barren. In some cases the streams have been dammed and the water carried on to the land by irrigating channels, while in other cases the water is raised by pumps driven by windmills or steam power. The crops grown on these irrigated lands consist of corn, cotton, tobacco, oranges, and other fruit. The description given below applies to the largest enterprise yet undertaken, but which is typical of many others.

The great plain of Northern Mexico is bounded on the east and west by the sierras of the Pacific and Gulf coasts, and is situated at a height of 4000 feet above the level of the sea, covering an area of about 240,000 square miles. This basin receives the drainage from several rivers which run into large shallow lakes, whence the water gradually evaporates during the dry season. The alluvial matter brought down during long periods has completely filled some of these lagoons with a deposit of the finest alluvial soil of unknown depth. About fifty years ago tracts of this fertile land bordering on the river Nazas, and covering about 250,000 acres, were brought under cultivation by a system of ditches and banks, and on this was produced a great part of the cotton grown in Mexico.

Separated from the river by a tract of 30 miles of barren desert land, is one of the richest districts in Mexico, being the site of an ancient lake called Tlahualilo, but until the present enterprise was undertaken the conveyance of the water from the river to this land presented an obstacle to its cultivation. In 1889 a company was formed, and works carried out for irrigating this district extending over 210 square miles. The concession of the water rights having been obtained, a dam was constructed across the river Nazas, and the water conducted from there across the desert by means of a canal, 39 miles in length, and 72 feet wide at the bottom, and 6½ feet deep, to the entrance of the area to be irrigated, when it branched off into two other canals, one 15 miles and the other 13 miles long. These side canals were prolonged down each side of the basin, meeting at the further extremity, and enclosing an area of 57,000 acres. The irrigated area was laid out in separate tracts or "sitios," containing 4338 acres, the area controlled by each subsidiary drain being 134 acres. The total length of the main drains and ditches was 479 miles. The difficulties encountered in carrying out this work were very great. For 25 miles of the distance along which the main canal was carried, all the water for the men and animals employed had to be carted, as well as the supply of food for the 2000 to 3000 Indians employed. On the completion of the canal, on the "sitios" were erected the buildings necessary for forming villages, with houses for the men and their families engaged on the land, together with magazines, farm buildings, storehouses, and reservoirs for water, each "sitio" being placed under the control of a separate manager and staff. At the central station, in addition to the above, were erected a steam cotton-gin and press, oil mills, soap factory for utilising the oil product, and electric light plant. There were also built a church, public schools for the children, a market, hospital and other conveniences for the welfare of the population. The number of steam-engines employed on this estate aggregate over 300 horse-power, the fuel for which consists principally of the hulls of the cotton-seed and the wood derived from clearing the bush. The engines and machinery are operated by native labour, the peons being found quick and apt in acquiring mechanical knowledge.

The result of this enterprise has been very satisfactory, and six years' experience shows that irrigation when applied to fertile land in a systematic manner renders agriculture in the climate of Mexico highly remunerative, and reduces the uncertainty and hazard of obtaining crops to far less proportions than where their successful cultivation is dependent on rainfall. There is a very large area of similar good land not used in Mexico owing to lack of water, the risk of depending on the rainfall being considered too great.

RIDGWAY'S BIRDS OF THE GALAPAGOS.[1]

IT was Darwin, in his "Naturalist's Voyage," who first called attention to the peculiarities of the fauna of the Galapagos, and urged the importance of its more accurate study. Wallace, in "Island Life," has devoted a whole chapter to the discussion of the curious phenomena of distribution which it presents, and which are in no case better exhibited than in the class of birds. The National Museum of Washington has of late years acquired a very fine series of Galapagan birds, principally through the exertions of the naturalists of the *Albatross* in 1888 and 1891, and from the collections made by

[1] "Birds of the Galapagos Archipelago." By Robert Ridgway. R.U.S. Nat. Mus. xix. Pp. 459-670. (Washington, 1896.)

Messrs. Baur and Adams in 1891. Although the subject is by no means as yet exhausted, Mr. Robert Ridgway, the able and energetic Curator of the Department of Birds at Washington, has thought it expedient to collate the knowledge thus far secured, and to facilitate future investigations by the preparation of the memoir now before us.

The last complete account of the avifauna of the Galapagos was that given by Mr. Salvin in the *Transactions* of the Zoological Society of London in 1876, in which he showed that fifty-seven species of birds were then known to occur in the Galapagan group, of which thirty-eight were peculiar. Mr. Ridgway's revised list proves that good progress has been made in our knowledge of the birds of these islands during this past twenty years. He shows us that 105 species are now known to be included in the Galapagan avifauna. These he refers to forty-six genera, of which five (*Nesomimus*, *Certhidea*, *Geospiza*, *Camarhynchus* and *Nesopelia*) are peculiar to the group. The first four of these, besides some others, are represented in many of the islands by peculiar species. Mr. Ridgway treats of all the Galapagan species one after another in a most complete manner, stating their specific characters, synonyms and distribution, and adding a list of the specimens contained in the National Museum of the United States. Moreover, the ranges of the different species are clearly shown in a series of outline maps.

As regards the explanation of the fact that the species of the Galapagan fauna are mostly confined to certain islands of the group, Dr. Baur, in his biological lectures delivered in 1894, put forward the view that at a former period the islands were connected with one another and formed a single large island, of which all but the higher points (which now constitute the islands) have been since submerged. Mr. Ridgway does not positively adhere to this view, although he pronounces it to be "at least worthy of serious consideration."

THE LATE PROFESSOR ROY, M.D., F.R.S.

FOR some long time past Prof. Roy, of Cambridge, has been in very serious ill-health. On Monday, the 4th of this month, death somewhat suddenly removed him from among us. He was only forty-three years of age. The news of the loss of so gifted a worker, and so enthusiastic a leader in investigation, will come as a heavy blow to many throughout the civilised world who have at heart the progress of scientific pathology. His adopted University had already had to deplore its loss in his failing health and powers.

Prof. Roy—Charles Smart Roy—was a native of Arbroath. His education was received at first in that town, then in the University of St. Andrews, then in that of Edinburgh. At the last-named he graduated in medicine as a Bachelor in 1875, and was subsequently appointed a resident physician at the Royal Infirmary in the wards of Dr. Balfour, well known as an authority on valvular lesions of the heart. On the completion of the term of that office Roy migrated to London, and opened original research work on the contagious pleuro-pneumonia of cattle. However, at the outbreak of the Turkish-Servian war he volunteered for service. As a Surgeon-Major in the Turkish army he was given charge of the large garrison hospital at Janina in Epirus. Epirus remained untouched by the active fighting of the campaign, and during his period of service Roy in spare hours designed an instrument for recording changes in the volume of the frog's heart—his frog-cardiometer. At the close of the war he returned to London and finished his investigation into pleuro-pneumonia, conducting it at the Brown Institution, where Prof. Burdon-Sanderson was then superintendent. This work is the only one by him which deals mainly with morbid anatomy. He proceeded next to Berlin. At that time he had the intention of devoting three years on the continent to improvement of his medical knowledge, with a view to returning ultimately to medical practice. At Berlin he studied pathology in Prof. Virchow's laboratory, but he also commenced in Du Bois' laboratory an investigation into the physiology of the heart, chiefly with use of the cardiometer already alluded to. He was thus one of the earliest workers in Du Bois-Reymond's new and palatial Physiological Institute, where Prof. Kronecker was then chief assistant. The results of his research were embodied in a dissertation for the degree of Doctor of Medicine of Edinburgh: the thesis was awarded a gold medal by the University, and the Doctor's degree was proceeded to in 1878. In the same year his remarkable paper "On the influences which modify the work of the heart" was published in Foster's *Journal of Physiology*, a paper based chiefly on the work done for his thesis.

In the course of the next year Roy was appointed assistant at the Physiological Institute of the Strassburg University, under Prof. Goltz. As assistant there, his time could be given practically entirely to research, and was so with noteworthy results. He devoted himself to "Observations on the form of the pulse-wave as studied in the carotid of the rabbit." The paper showed more clearly than either of his previous the advent of an investigator of originality and power. An instrument was invented for the research—the sphygmotonometer, an ingenious plethysmograph adapted to record the changing volumes of the free but unopened blood-vessel. Specimens of the original tracings obtained by it hang now as models of reference in more than a few laboratories both at home and abroad. It was also about this date that he devised his instruments for measuring and recording graphically the measurements of the extensibility and elasticity of the walls of blood-vessels. These latter are the subject of his second paper in Foster's *Journal*, and the data he obtained are now incorporated as part of text-book knowledge in physiology. The chief instrument he used presents points of similarity to the myographion, the principle of which was suggested to Prof. Blix by the late Fritjof Holmgren; but Roy's instrument preceded the Holmgren-Blix instrument, and was evolved altogether independently of that.

In the same year (1879) appeared his work, done in conjunction with Dr. Graham Brown, on capillary blood-pressure, published in Foster's *Journal*. The research carried out, we believe at odd hours in the dwelling-room of the two friends, furnished more trustworthy measurements than any pre-existing. By an ingenious apparatus these absolute measurements, very important for the physiology of the circulation, were unexceptionably obtained. It was in the same, or in the previous, year that Roy devised the ether-freezing microtome. The instrument came into use largely in Great Britain and on the continent, and his original pattern, little modified, is still employed in many laboratories.

Roy now, always keen to apply his work to practical medicine, moved from the physiological to the pathological laboratory at Strassburg; but he soon left v. Recklinghausen's to attend Cohnheim's institute at Leipzig. There, in personal communication with Cohnheim, his attention was attracted especially to problems concerning vascular changes in the kidney. He devised the instrument by which perhaps his name is best known, the renal oncometer, for the study of the variations of the blood-flow through the kidney. The observations accessible by this instument have become familiar to every physiologist and pathologist. The research which by its aid its inventor, with Cohnheim, prosecuted on the renal circulation remains a classic in the literature of th

circulation. The acquaintanceship of the two workers rapidly ripened into intimate friendship. Kuhne in his memorial sketch (1885) of Cohnheim wrote: "Once only did his name appear in actual association with that of a pupil, to wit in association with that of the present Professor of General Pathology at Cambridge, Charles Roy, in the 'Researches on the Circulation in the Kidneys.' These exact and laborious researches, through which the younger worker and the elder must go down to posterity together, were the last that Cohnheim ever edited himself, and in their prosecution it was a delight to him to admire the extreme skill and the happy facility of his younger colleague, well suited as those gifts were to prosecute scientific pathology in the very direction in which he himself believed it could prosper best." Cohnheim's death in 1884, at the early age of forty-five, was felt by Roy as a severe personal loss. He often spoke of Cohnheim in terms of enthusiastic admiration. He looked upon himself as in a way representing in this country the leadership which Cohnheim held as a pathologist of a new school in Germany. Roy stayed at Leipzig nearly a year. While there he received the G. H. Lewes studentship for research in physiology. This studentship had just been founded by "George Eliot" in memory of her deceased husband, and Roy was its first recipient.

In tenure of this studentship he worked in Prof. Michael Foster's laboratory at Cambridge, and thence issued his paper "On the Physiology and Pathology of the Spleen" (*Journal of Physiology*, vol. v.). This communication contains his discovery of an autochthonous rhythmic tonicity in the mammalian spleen; the vasomotor reactions of the organ were also elucidated. In 1880 he was elected a member of the Physiological Society. While then at Cambridge he lectured to advanced students of physiology on the elasticity of animal tissues. In 1882, on the election of Prof. Greenfield to the Edinburgh chair of General Pathology, Roy was chosen to succeed him as Professor Superintendent of the Brown Institution. There he plunged into the work on the action of the mammalian heart, which he never relinquished until nervous breakdown divorced him from his laboratory.

Soon after his installation at the Brown Institution, Roy was commissioned to investigate in the Argentine Republic a disease which was devastating the herds in the province of Entre Rios. He succeeded in alleviating the mischief by a preventive inoculation. He used the viscacha as medium for attenuating the intensity of the virus. The year 1884 was especially eventful for him. Early in that year he published his valuable method for measuring the specific gravity of the blood, a method suitable for and used with great success in conducting clinical observations. In May he was elected a Fellow of the Royal Society, and soon after that he was elected to the newly-instituted chair of Pathology in the University of Cambridge. He was elected a member of the Alpine Club almost in the same week. He was then in his thirtieth year. In the following summer, 1885, Asiatic cholera having appeared in a very severe epidemic form in Spain, he spent the middle and autumn of the year in prosecuting investigations into the bacteriology of the epidemic with his friends Dr. Graham Brown and Prof. Sherrington. The report of the observations obtained was presented to the Royal Society in the year following.

Although his activity at Cambridge during the later tenure of his chair has suffered under his failure of health, and in the early period was hampered by want of adequate accommodation in the matter of buildings and equipment, Roy's work for his department in the short time that it had free scope was marked by conspicuous success in many ways. In 1887, with the co-operation of Sir Richard Webster, he succeeded in securing the foundation of the J. Lucas Walker Studentships in Pathology. These have been of the greatest benefit, both in furthering discovery and in training investigators in scientific pathology. The selection of the candidates for these studentships lay largely with the Professor of Pathology; in his laboratory the whole or main part of their work was accomplished; in it and in them he always took the keenest interest, following their progress with eagerness. The mere recital of their names (Dr. William Hunter, Prof. Adami, Prof. Kanthack, Dr. Lorrain Smith, Prof. Wesbrook, Dr. Cobbett) suffices to indicate the sterling success Roy achieved in this department of his office. The lectures on pathology were on Roy's appointment at first delivered in the old theatre, for the Regius Professor of Physic, adjoining the Medical Museum; the work of research and teaching at that time was carried on in rooms lent by Prof. Foster from the physiological laboratory. It was there that the research on the "Mechanism of the Circulation in the Brain," undertaken in conjunction with Prof. Sherrington, was carried out (*Journal of Physiology*, vol. x.). But in 1889 buildings vacated by the Chemistry School were transformed and refitted to receive the department of Pathology. In the better laboratory several able pupils joined him—Griffiths, Rolleston, Hankin, Keng, Hardy, and Barlow; Prof. Arthur Gamgee, and Prof. Filehne of Breslau also for some time worked there. A rapid output of excellent work in experimental pathology resulted: researches on endocardic pressures, on the relation between heart-beat and pulse-wave, on the specific gravity of the blood, on the seat of production of hæmoglobin, on mechanisms protective against infection, on the causation of "shock," on the formation of lymph—in all these he actively interested himself, encouraging them absolutely unselfishly. Although his interest in biology was strikingly catholic, problems connected with the circulation had perhaps a paramount attraction for him always; and in 1892 appeared in the *Philosophical Transactions* the long work on the mammalian heart, carried out with Prof. Adami. Instruments were to a large extent specially devised for this research, and some of these have already become means of investigation in other laboratories besides those at Cambridge. The cardiac plethysmograph, and the cardiomyograph, and the automatic counter, were each examples of ingenuity that never failed to meet with resource the mechanical difficulties of a subject numerously beset by them.

Prof. Roy was one of the earliest—perhaps the earliest one—to originate that movement that has resulted in the foundation of the British Institute of Preventive Medicine. To furtherance of the project he devoted much time and work. He advocated its obtaining a site at or near Cambridge: that his advice was not followed on this point, was always to him a matter of deep regret. In 1893 he was President of the Section of Pathology at the annual meeting of the British Medical Association at Newcastle. He took as the subject for his brief but vigorous address the defensive mechanisms exhibited by the animal body under the assault of disease. In 1894 he attended the Section of Physiology at the meeting of the British Association at Oxford, and took an active part in its sessions. The flight of birds, the possibility of flight by man, the construction of flying machines formed a favourite theme with him, and one in which he had made some original observations and experiments: in connection with it he contributed an essay on Flight to Prof. Newton's Dictionary of Ornithology. On coming to reside at Cambridge he became attached to Trinity College. In 1887 he married Violet, daughter of Sir George Paget, the late Regius Professor of Physic in the University. Nearly a year before Prof. Roy's death the condition of his health had led to the appointment of a Deputy-Professor, Prof. A. A. Kanthack.

A man of strong convictions, almost impetuous in his

determination to act upon them, Roy, as a pathologist, had the firm belief that the future science of pathology was most surely and most quickly to be reached along the same lines of advance as physiology has followed with signal success, especially since Ludwig and Bernard. The inferences to be drawn from the mere anatomical study of structural changes induced by morbid processes he considered to be practically exhausted. Indeed, he thought much time had been wasted in pushing such observations into confines of hair-splitting minuteness and detail. It would be, however, wrong to suppose he took little interest in microscopy. On the contrary, new methods of staining tissues, and colouring bacteria, and of following appearances of phagocytosis appealed to him strongly and immediately, and he was early to follow them. It was rather that the laborious unravelling of an individual autopsy by prolonged histological search and anatomical induction seemed to him unfruitful labour, and he gave little time to it. He turned to physical and, especially, to mechanical methods. His ingenuity in devising and his manual skill in the using of mechanical apparatus was, as Kuhne wrote, quite "extraordinary." Indeed, it was to a certain extent harmful to the quality of his work. It limited the scope with which he undertook and the depth to which he pursued a subject. It continually tempted him to wander from investigations toward which he had already accomplished the preliminaries, to open fresh ground in some other direction. A plan usual with him in his own work was to set before himself the obtaining of some particular measurement, *e.g.* the volume of an organ under certain conditions; the more difficult the experiment, the more attraction had it for him; he devised appropriate apparatus, tried it, altered it, made it successful, obtained a certain number of complete experiments, and then moved to another problem often not cognate with that previously taken up. The accuracy and rapidity with which he dissected were surprising, and for dexterity as an operator in the laboratory he had no rival in this country. His scientific papers were all written in a brief, simple and direct style, without repetition of statement, and usually without even any final recapitulation. Protocols of experiments were almost always excluded from them.

As a teacher his career commenced with his advent to Cambridge. His lectures were marked by striking and suggestive thoughts. The matter of them suffered somewhat from the rapid manner of their delivery. He cherished an intention to publish a volume of lectures on the pathology of the circulation; many of his lectures on this subject were brilliantly original. He did not illustrate his lectures by any experiments performed in the lecture hour. In the ordinary students who attended his classes simply for examination purposes he took curiously little interest; whether they passed or failed, attended or did not attend, seemed to go unnoted by him. To those who came to him to pursue research, even of the most unambitious kind, he was a different man. These he treated almost at once as personal friends, and he attached them to him by many ties of kindness and respect. In regard to their work, he was always absolutely sympathetic, equally so in failure and in success. In facing difficulties with them in the experiments they might have in hand, he encouraged with an undaunted cheerfulness of manner, and gave time and thought completely unstintingly in their companionship. He had been heard to confess an ambition to create a school of work in his laboratory somewhat on the lines of that formed in Ludwig's laboratory at Leipzig. Had his original strength been maintained, the results that his life had already produced are earnest, we think, that his ambition would not have been unfulfilled. As it is, his contributions to the study of the mechanisms concerned with the circulation of the blood can of themselves assure to him a lasting place in the esteem of all biologists.

Prof. Roy was buried at Cambridge on Friday, the 9th inst. The first portion of the burial service was held in the chapel of Trinity College, and was attended by many office-bearers of the University and other members of the Senate. The chief mourners were Mr. James Roy, of Arbroath (brother), Mr. Edmund Paget, Mr. Meyrick Paget, Dr. and Mrs. Hans Gadow, Prof. J. J. Thomson, Prof. Sherrington, Prof. Kanthack, Dr. Lazarus-Barlow, Mr. Cobbett, Mr. Graham Kerr, and Miss Kingsley (niece of the late Charles Kingsley). The clergy officiating in the chapel were the Master of Trinity (Dr. H. Montagu Butler), the Senior Dean (Rev. A. H. F. Boughey), and the Rev. L. Borissow (Precentor). The interment took place at the Mill Road Cemetery, where the Rev. Dr. Thomson, of Oxford, officiated. The proceedings at Trinity were attended by the Vice-Chancellor (Dr. Hill), the Master of Sidney, the Master of Christ's, the President of Queens', Prof. Allbutt, Prof. Macalister, Prof. Bradbury, Prof. Forsyth, Prof. Newton, Prof. Cowell, Prof. Mayor, Prof. Ewing, Prof. Stanton, Dr. Gaskell, Dr. L. Humphry, Dr. Jackson, Dr. Ruhemann, Dr. William Hunter, Dr. Griffith, Dr. Cunningham, Dr. Langley, and Dr. Postgate.

NOTES.

AT the annual general meeting of the London Mathematical Society, which will be held on November 11, the following names will be proposed for election on the Council of the ensuing session:—President, Prof. Elliott, F.R.S.; Vice-Presidents, Major MacMahon, R.A., F.R.S., Dr. Hobson, F.R.S.; Treasurer, Dr. J. Larmor, F.R.S.; Hon. Secretaries, R. Tucker, A. E. H. Love, F.R.S. Other members: Lieut.-Colonel Cunningham, R.E., Dr. Glaisher, F.R.S, Prof. Hill F.R.S., Prof. Hudson, M. Jenkins, A. B. Kempe, F.R.S., F. S. MacAulay, D. B. Mair, G. B. Mathews, F.R.S., W. D. Niven, C.B., F.R.S.

SIR PETER LE PAGE RENOUF, the eminent Egyptologist, and for several years keeper of the Egyptian and Assyrian antiquities at the British Museum, died last week, at the age of seventy five.

DR. VICTOR HORSLEY, F.R.S., has been returned at the head of the poll in the recent election for a direct representative on the General Medical Council.

THE Queen has conferred upon Dr. H. Hicks, F.R.S., president of the Geological Society, the Jubilee medal in commemoration of the sixtieth anniversary of her Majesty's reign.

REUTER'S Agency reports that the Imperial Russian Geographical Society is fitting out an expedition to Abyssinia for the purposes of anthropological research. The expedition, which will be under the leadership of M. Dmitrieff, will start during the present autumn.

THE death is announced of Mr. James Heywood, who took an active part in the movement for the abolition of theological tests at universities. Mr. Heywood was elected a Fellow of the Royal Society as long ago as 1839; he was also a Fellow of the Geological Society, and published several works on geological subjects.

WE regret to announce the deaths of Mr. William Scott, Director of the Royal Gardens and Forests, Mauritius; Dr. F. W. Barry, senior medical inspector to the Local Government Board; Dr. Hjalmar Heiberg, professor of pathological anatomy in the University of Christiania; Dr. Hermann

Welcker, sometime professor of anatomy in the University of Halle, and a distinguished anthropologist; Dr. R. Branchat, professor of hygiene in the Medical Faculty of Granada; Dr. Leopold Auerbach, assistant professor of physiology in the University of Breslau; Mr. Percy Lund Simmonds, the author of numerous works on various branches of technology.

THE International Leprosy Conference was opened at the Imperial Board of Health, Berlin, on October 11. Prof. Virchow was elected President of the Conference, and on his proposal Prof. Lassar (Berlin) and Dr. A. Hansen (Bergen) were elected Vice-Presidents, and Dr. Ehlers (Copenhagen) Secretary-in-Chief. The Conference has appointed a commission composed of twenty members, with power to add to its number, to confer and prepare the way for an International Leprosy Society.

PHYSIOLOGICAL chemistry has just lost one of its most diligent and capable workers in the person of Dr. Edmund Drechsel, professor of physiological and pathological chemistry and of pharmacology in the University of Berne. At the time of his sudden death, Dr. Drechsel was at Naples working in the Zoological Station there at some of those problems in the chemistry of the invertebrates which have recently absorbed much of his attention. On September 22 he died suddenly of disease of the heart, at the age of fifty-four. The *British Medical Journal* gives the following particulars of the career of this distinguished exponent of the chemistry of physiology:—Born in Leipzig in 1843, he studied chemistry at the University there with such success, from 1863 onwards, that in 1865 he became assistant to Kolbe, who was then professor of chemistry. He took his Doctor's degree in Philosophy in 1865. In 1872 Ludwig appointed him his assistant in the Chemical Department of the Physiological Institute, where he carried on many researches, and aided Ludwig and his numerous pupils when they required assistance in matters chemical. In 1878 he was elected Extraordinary Professor in the Medical Faculty, and remained at Leipzig under Ludwig until he was called to Berne to fill the chair of Physiological Chemistry there. In 1883 the University of Leipzig conferred upon him the degree of M.D. Much to his regret, Drechsel did not follow a medical career. He entered upon the study of physiology purely from the chemical side, so that his work—always of the highest class and carefully done—dealt rather with problems of a distinctly chemical nature. He was a laborious and painstaking worker, and whatever he did was done thoroughly. Drechsel made many contributions to physiological chemistry, and he was a perfect encyclopædia of knowledge regarding chemical problems.

IT is so commonly assumed that poetry and science are antagonistic, that an address delivered by the Poet Laureate, Mr. Alfred Austin, at the opening of a new school of science and art last week, deserves a wide publicity. Macaulay, with his well-known love of antithesis, once endeavoured to show that as civilisation advances, poetry almost necessarily declines; and taking science as one of the most important factors in the civilising process, the inference is that a poet with a knowledge of scientific facts labours under a disadvantage. Now, however, we are able to give a Poet Laureate's opinion that science and art are complementary to one another and not rivals. Science, said Mr. Austin, is exact knowledge—that and nothing more. But exact knowledge is the foundation of all the arts, and no man ever achieved real greatness in any of them who did not have the firmest grasp of the permanent facts which underlie them. Music, the most intangible and fantastic of the arts, cannot move one step, nor excite a single emotion without submitting to the severe discipline of numbers. Finally, the matter of a poet's verse is not of much account unless it be animated by the scientific spirit of close and wide observation and of loving accuracy. There is thus no means of getting away from exact knowledge or science if one aspires to be an artist. It must be obvious to any one who has read the "Divina Commedia" that the greatest poet of the middle ages, than whom there was none greater in any age, was thoroughly familiar with all the science or exact knowledge of his time; and Leonardo da Vinci, who might have equals, but had no superior in the realm of painting, was not more fascinated by artistic conceptions than by what are called scientific problems; and at these he laboured indefatigably. Alike, therefore, by necessity and choice, art exhibits a sympathetic kinship with science. The scientific spirit, far from being hostile to the artistic spirit, is ancillary to it, for, as Dryden said, "Genius is perfected by science." The noblest manifestations of both have always occurred in one and the same epoch. Athens produced Euclid as well as Praxiteles; the vigorous old age of Michael Angelo overlapped the precocious youth of Galileo; and Bacon was the contemporary of Shakespeare. And though the century now drawing to a close has been pre-eminently a scientific century, the locomotive and the telephone will not be more enduring than the verse of Byron and Tennyson, or than the pictures of Turner and Watts. The reasoning intellect is the foundation alike of science and of art; but, concluded Mr. Austin, while reason alone suffices to science, art is reason transfigured by emotion.

THE Harveian Oration was delivered before the Royal College of Physicians on Monday by Sir William Roberts, F.R.S., who considered Harvey's life and work, not so much as they concern special studies, but as symbolising the commencement of a new era in human progress—the era of exact science—which, in the present age, is slowly but surely transfiguring the aspects and prospects of civilised society. He remarked that, speaking broadly, the older civilisations rested essentially upon art and literature (including philosophy), while modern civilisation rests, in addition, upon science and all that science brings in its train. A sharp distinction must be drawn between the so-called science of antiquity and the science of to-day. The ancients had a large acquaintance with the phenomena of nature, and were the masters of many inventions. They knew how to extract the common metals from their ores; they made glass; they were skilled agriculturists; they could bake, brew, and make wine, manufacture butter and cheese, spin, weave, and dye cloth; they had marked the motions of the heavenly bodies, and kept accurate record of time and seasons; they used the wheel, pulley, and lever; and knew a good deal of the natural history of plants and animals, and of anatomy and practical medicine. This store of information had been slowly acquired in the course of ages—mostly through haphazard discovery and chance observation—and formed a body of knowledge of inestimable value for the necessities, conveniences, and embellishments of life. But it was not science in the modern sense of the word. None of this knowledge was systematised and interpreted by coordinating principles; nor illuminated by generalisations which might serve as incentives and guides to further acquisitions. Such knowledge had no innate spring of growth; it could only increase, if at all, by casual additions—as a loose heap of stones might increase—and much of it was liable at any time to be swept away into oblivion by the flood of barbaric conquest. It is quite obvious, from the subsequent course of events, that there came into the world of natural knowledge about three centuries ago, in the time of Galileo and Harvey, a something—a movement, an impulse, a spirit—which was distinctly new—which Bacon, with prophetic insight, termed a "new birth of time." This remarkable movement did not originate with any startling revelation; it consisted rather in an altered mental attitude, and a method. There arose a distrust in the dicta of authority, and

an increasing reliance on ascertained facts. These latter came to be regarded as the true and only data upon which natural knowledge could be securely founded and built up. Doubt and question took the place of false certainty. The hidden meaning of phenomena was sought out by observing them under artificially varied conditions—or, to use the words of Harvey, "the secrets of nature were searched out and studied by way of experiment." *A priori* reasoning from mere assumptions, or from a few loosely observed facts, fell into discredit. Observations were repeated, and made more numerous and more exact. These were linked together with more rigid reasoning to stringent inductions. Hypotheses (or generalisations) were subjected to verification by experiment; and their validity was further tested by their efficacy in interpreting cognate problems and by their power to serve as guides to the acquisition of fresh knowledge. The invention of instruments and appliances for assisting research was an essential and invaluable feature of the "new philosophy." Physiology and practical medicine have profited immensely by the general advance of the sister sciences, and by the adoption of scientific methods in the prosecution of research. Optical science gave birth to the achromatic microscope. The microscope has laid bare the minute structure of plants and animals, and introduced zoologists and botanists to a vast subkingdom of minute forms of life previously undreamt of. The microscope also, in conjunction with chemistry, founded the new science of bacteriology. Bacteriology has inspired the beneficent practice of antiseptic surgery; it has also discovered to us the parasitic nature of zymotic diseases, and opened out a fair prospect of ultimate deliverance from their ravages. Thus have the several sciences advanced, and are still advancing, in concert, step on step, by mutual help, at an ever-increasing speed—pushed on by that irrepressible forward impulse which has characterised the scientific movement from its inception.

MR. ARNOLD PIKE has been cruising this summer in the eastern part of the Spitsbergen archipelago, and, owing to the sea being exceptionally free from ice, was able to make some interesting observations. Stor Fiord was found to be open in the beginning of August, and Mr. Pike's whaler, the *Victoria*, was able to pass northward through Helis Strait, which at the same date last year was closed by fast ice, into Hinlopen Strait. Mr. Pike succeeded in getting as far east along the north coast of North East Land as Charles XII. Island. The ice was there jammed against the shore, and prevented the circumnavigation of North East Land. The *Victoria* then returned down Hinlopen Strait, and steamed eastward to Wich's Land and King Charles' Land. They searched for the islands reported in 1884, by Johannesen and Andreassen, which Captain Robertson earlier this year showed to be non-existent. Mr. Pike adds a reasonable explanation of the source of the error. No old pack ice was seen during the whole voyage, and these exceptional conditions appear to have prevailed throughout the whole of the Greenland and Spitsbergen seas.

THE Meteorological Reporter to the Government of India has just published his annual summary of the *India Weather Review* for 1896, which completes the discussion of the meteorology for that year. In this work the data are presented from two different points of view: (1) for the discussion of the prevalence and spread of disease, and (2) in connection with agricultural questions. For the comparison of medical and meteorological statistics, India is arranged into eleven provinces, the data for each of which are given in a tabular form, while for the second purpose the whole area is divided into fifty-seven meteorological districts. The volume contains a very large amount of useful information, from which we abstract a few general remarks. The mean temperature of the whole of India was normal, or in excess, throughout the year, being more than 2° in April, May and November. The absolute maximum of the year was 123°, at Jacobabad. The year was the driest on record during the past twenty-two years, the mean humidity being 3 per cent. below the normal; this was chiefly owing to the high temperature, as the mean aqueous vapour pressure was only ·01 inch below the average. The rainfall of the year averaged 4·83 inches (or 12 per cent.) below the normal; the deficiency was greatest in Berar (34 per cent.), and in the North-west Provinces and Central India (31 per cent.), and was chiefly due to persistent weakness of the south-west monsoon, and its withdrawal from those parts, from three to seven weeks earlier than usual. The deficiency in 1896 was much more serious than in 1895, and led to the partial failure of the crops over an unusually large area.

AN interesting instance of the effect of geological structure upon local values of magnetic declination is described in the *Journal* of the Franklin Institute (October) by Mr. Benjamin S. Lyman. It appears that about the year 1883 a number of determinations of the compass variation in the counties of Bucks and Montgomery, Pennsylvania, were made, and a chart showing curves of equal declination for every tenth of a degree was constructed from the observations. A striking feature brought out by this magnetic map was that all the isogonic lines had a sharp bend, the convex side of which pointed north-eastward towards New Hope and Lambertville, on the Delaware. The curves are so extremely at variance with the simple, nearly straight lines of earlier maps, that the observations upon which they were based were suspected of being incorrect; they have, however, now been beautifully confirmed by geology. The geological survey of the two counties, begun at the end of 1887, has now proved beyond question the existence of an enormous fault, of about 14,000 feet, in the rock beds, almost precisely on the line of the Delaware River end of the axis of the bend in the curves, and following the same course from there westwards. In other words, the axis of the bend in the magnetic curves lies directly above the line of fault determined by geological observations. The topography of the region shows no strongly-marked ridge following the course of the axis of the curves, neither does the form of the out-cropping rocks, sedimentary or igneous, correspond in any way with them; but there is no doubt that the remarkable magnetic peculiarity of the region is related to the equally remarkable and completely corresponding geological structure. This confirmation of one set of observations by another of a different character, and made quite independently, furnishes a striking instance of the connection between different branches of scientific investigation.

MR. W. F. LLOYD, in giving a brief description of experiments made by him to determine the specific heat of human blood, in the *British Medical Journal*, mentions that this physical property appears not to have been previously investigated in this country. The results obtained in his experiments give 0·710 as the specific heat of human blood. Having determined this value, the amount of heat required to raise the temperature of a certain quantity of blood can, of course, be easily calculated. Suppose that the temperature of a patient whose weight is 65 kilogrammes is 37° C., and twelve hours after this the temperature has gone up 3° C. The weight of the patient's blood would be $\frac{1}{13}$ of 65, or 5 kilogrammes, and the amount of heat required to raise the temperature of 5 kilogrammes 3° C. will be: $5000 \times 0{\cdot}71 \times 3 = 10{,}650$ heat units, the mechanical equivalent of which is 4,515,600 grammetres. This amount of work represents the chemical energy which must be required to raise the temperature of the blood of the patient 3° C. in twelve hours, so that in every second the chemical changes going on are represented by the amount of energy required to lift 104·5 grammes 1 metre high against the force of gravity. From this

it will be seen that the amount of energy going on in the tissues of a patient whose temperature is rising must be very considerable, and about thirteen times greater than the above figures, for these figures apply only to the blood. Mr. Lloyd suggests that the difficult problem with regard to the number of atoms in the molecule of protoplasm, which has hitherto baffled physiologists, may be finally solved by an accurate determination of the specific heat of living protoplasm.

WE are sorry to learn that Mr. Alfred Allen, of Bath, finds it necessary to discontinue the *Journal of Microscopy and Natural Science*, which he has edited for the last sixteen years, in consequence of the circulation being slightly too small to cover the cost of publication. The last number is one of the best that we have seen, and contains articles by Dr. Jabez Hogg on "The so-called Jumping Bean of Mexico," by E. Steinhouse on "How Plants live and work," and a reprint of an important paper by Dr. August Forel, of Zürich, on "Ants' Nests." The Postal Microscopical Society, with which the *Journal* was semi-officially connected, will still be continued.

THE problems of the liquefaction of the more permanent gases has always aroused a considerable amount of scientific interest, and this has been especially the case with fluorine, in which there is the added difficulty of the extraordinary chemical activity of the gas. The successful issue of this problem was first announced by Profs. Moissan and Dewar in May last (see p. 126), and in the current number of the *Comptes rendus* of the Paris Academy of Sciences, there is a further contribution to this subject by the same authors. In the preliminary account, especial interest was excited by the description of a white explosive substance, apparently a compound of fluorine and oxygen; it is now shown, however, that liquid fluorine and liquid oxygen mix in all proportions if the oxygen is perfectly dry, and that it is the presence of moisture which determines the formation of the white explosive body, which would appear to be simply a hydrate of fluorine, decomposable with detonation by a slight rise of temperature. In the earlier experiments it was found that fluorine could not be liquefied by oxygen boiling under atmospheric pressure, but it is now shown that freshly prepared liquid air, boiling under the same conditions, can effect the liquefaction. The boiling point of fluorine is found to be $-187°$ C., and there is no sign of solidification nor even of loss of mobility at $-210°$ C. The density of fluorine, as determined by the flotation of solids of known density, is 1·14, and the liquid is devoid both of magnetic action and of any absorptive effect upon the spectrum. The chemical reactions of the liquid are curious, as although at $-210°$ there is no action upon water or mercury, it still combines violently with hydrogen and essence of turpentine. A little of the liquid fluorine, accidentally spilt, set fire to the wooden floor.

THE subtropical garden of Mr. Thos. Hanbury, at Palazzo Orengo, La Mortola, near Ventimiglia, is well known to all visitors to the Riviera. Mr. Hanbury has just issued an alphabetical catalogue of plants growing in the open air in the garden, compiled by K. Dinter. It occupies fifty-three quarto pages. The native country is given of each species.

THE current number of the *Journal* of the Royal Statistical Society contains the Howard Medal Prize Essay, by Dr. James Kerr, on "School Hygiene, in its Mental, Moral, and Physical Aspects." The subject for the medal to be awarded in 1898 (with 20*l.* as heretofore) is "The Treatment of Habitual Offenders, with special reference to their Increase or Decrease in various Countries."

THE Physical Society of London meets on Friday, October 29, at the rooms of the Chemical Society. Prof. Stroud will exhibit and describe the Barr and Stroud naval range finder, and also a telemetrical focometer and spherometer; Mr. Ackermann will exhibit a surface-tension experiment.

AT the meeting of the Chemical Society on Thursday, November 4, the following papers will be read:—"The Properties of Liquid Fluorine," by Profs. Moissan and J. Dewar; "The Liquefaction of Air and the Detection of Impurities" and "The Absorption of Hydrogen by Palladium at High Temperatures and Pressures," by Prof. Dewar.

A NEW instalment of the second edition of Dr. W. Ostwald's "Lehrbuch der allgemeinen Chemie" has just been published by Engelmann of Leipzig. The first volume of the new edition was completed in 1891, and the first part of the second volume appeared in 1893. These portions of the work have already been reviewed in NATURE (vol. xlviii. p. 49, 1893). We announced nearly a year ago the publication of the first section of the second part of the second volume, dealing almost entirely with the history of chemical affinity, and now the second section has appeared. In this section chemical dynamics is treated under two heads—chemical kinetics and chemical statics. It is announced that the remaining parts of the work will be published in the course of next year, and we propose to defer our review until the work is completed. At the present time we will only say that chemists will be glad when the second volume is finished; for, to repeat the opinion already expressed in these columns, "its appearance will serve to complete a work which goes further than any other to show how chemistry and physics must be united in the endeavour to arrive at the real nature of material phenomena."

"THE Bibliography of X-Ray Literature and Research, 1896–1897," will be published in a few days by *The Electrician* Printing and Publishing Company. The book is edited by Mr. C. E. S. Phillips, who has also contributed an historical retrospect, and a chapter on "Practical Hints on Röntgen Ray-Work." The same Company will also issue at the end of October a new work by Messrs. Fisher and Darby, entitled "The Student's Manual to Submarine Cable-Testing." Mr. Young J. Pentland announces:—"Text-Book of Physiology, by British Physiologists," edited by Prof. E. A. Schäfer, F.R.S., two vols., illustrated; "Text-Book of Medicine, by British Teachers," edited by Dr. G. A. Gibson, illustrated; "Manual of Operative Surgery," by H. J. Waring, illustrated; "Manual of Diseases of Women," by Dr. J. Clarence Webster, illustrated; "Diseases of the Heart and Circulation," by Dr. G. A. Gibson, illustrated; "The Principles of Treatment," by Dr. J. Mitchell Bruce; "Diseases of the Kidneys," by Dr. Robert Maguire; "Manual of Midwifery," by Dr. R. Milne Murray, illustrated; "Examination of the Eye," by Simeon Snell, illustrated; "Edinburgh Hospital Reports," edited by Drs. G. A. Gibson, C. W. Cathcart, John Thomson, and D. Berry Hart, vol. v.; "Diabetes Mellitus: its Symptoms, Pathology, and Treatment," by Dr. R. T. Williamson.

A SHORT historical account of the Royal Society of Canada, and the work it has accomplished, is contributed to the *Canadian Magazine* by the honorary secretary, Dr. J. G. Bourinot, C.M.G. The Society was established on the initiative of the Marquis of Lorne, then Governor-General of Canada. The first meeting was held in May 1882, under the presidency of the distinguished geologist, Dr. (now Sir) J. W. Dawson. The membership to begin with amounted to eighty Fellows, who had written —to quote the constitution—"memoirs of merit or rendered eminent services to literature or science"; a number subsequently increased to a hundred, or twenty-five each to the four sections of (1) French Literature and History; (2) English Literature, History and Archæology; (3) Mathematical, Physical and Chemical Sciences; (4) Geological and Biological Sciences. From the very commencement the Canadian Royal Society has been composed of men who have devoted themselves with ability and industry to the pursuit of literature,

science and education in the Dominion. Thanks to the encouragement given by the Canadian Government, the Society has been able, year by year, to publish a large volume of the proceedings and transactions of its members. The papers and monographs therein contained embrace a wide field of literary effort—the whole range of archæological, ethnological, historical, geographical, biological, geological, mathematical and physical sciences; and they bear witness to fifteen years of creditable work for the intellectual welfare of the Dominion of Canada.

THE additions to the Zoological Society's Gardens during the past week include a White-collared Mangabey (*Cercocebus collaris*, ♀) from West Africa, presented by Miss Daisy Kendall; a Beisa Antelope (*Oryx beisa*), a Caffer Cat (*Felis caffra*) from Somaliland, two Arabian Gazelles (*Gazella arabica*, ♂ ♂) from Arabia, presented by Mr. J. Benet Stanford; a Zanzibar Antelope (*Nesotragus moschatus*, ♀), an Augur Buzzard (*Buteo augur*) from East Africa, presented by Mr. Cavendish; a Red River Hog (*Potamochærus penicillatus*, ♀) from West Africa, presented by Captain Smith, s.s. *Boma*: a Leopard (*Felis pardus*, ♂) from West Africa, presented by Captain Humfrey; a Chinchilla (*Chinchilla lanigera*) from Chili, presented by Mr. J. A. Wolffsohn; an Egyptian Ichneumon (*Herpestes ichneumon*) from Egypt, presented by Mr. Ernest A. Dixon; a Spotted River Turtle (*Emyda vittata*) from India, presented by Mr. A. Felix; a Geoffroy's Cat (*Felis geoffroii*), a Matamata Terrapin (*Chelys fimbriata*) from Brazil, presented by Mr. W. Brice; a Spotted Eagle Owl (*Bubo maculosus*), a Delalande's Lizard (*Nucras delalandii*), three Lineated Snakes (*Boodon lineatus*), eleven Rough-keeled Snakes (*Dasypeltis scabra*), four Crossed Snakes (*Psammophis crucifer*), ten Rufescent Snakes (*Leptodira holambœia*), two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*) from Port Elizabeth, South Africa, presented by Mr. J. E. Matcham; a Wapiti Deer (*Cervus canadensis*, ♂), two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens; a Great Wallaroo (*Macropus robustus*, ♀) from South Australia, purchased; a Cape Zorilla (*Ictonyx zorilla*) from South Africa, deposited.

OUR ASTRONOMICAL COLUMN.

THE LAW OF SPECTRAL SERIES.—Previously in this column (vol. lv. p. 137) we have referred to some of the work which has been done with the object of finding satisfactory formulæ for the computation of the wave-lengths of lines which form spectral series. Two further interesting communications have recently been published, which are important in that they suggest that the formulæ at present in use are only roughly approximate for the series as a whole, and that the anomalies which here and there are found may eventually be satisfactorily explained. The first of these communications is due to Prof. T. N. Thiele (*Astrophysical Journal* for August), who has for some time been occupied with investigations on the law of spectral series, and whose remarks are of considerable importance. The problem, as he states, is a very troublesome one, and those who occupy themselves with it cannot hope to make, so far as his experience goes, those little discoveries which relieve tedious investigations. In fact, one's fundamental assumptions often give way before the constant criticism to which they are exposed. The general law of series is, however, still wanting, although the more or less complete resolution of spectra into series may be now approximately accomplished. Prof. Thiele's work has proved that the law, which expresses the wave-lengths of the lines in a spectral series, must have the form

$$\lambda = f[(n + c)^2]$$

when λ is the wave-length, and c a constant which he calls the phase of the series: all other formulæ are only special cases of this general one. Accepting this formula and all its consequences some very interesting points arise, the most important being that it is necessary to take into account not only the lines corresponding to positive values of n, but those when n is less than 0. This involves that a *series* must in general be composed of *two groups of lines*, each of which would ordinarily be called a series, or, as Prof. Thiele calls them, two branches, but cases may arise when the two branches coincide. It does not necessarily follow that both series will always be seen, as the intensity of one may be much less than that of the other. In cases where there are three, four, or more branches, the pairs of branches must be separated out. Another point which arises from this new idea is the question as to whether the double series, ordinarily found in metallic spectra, may not also be regarded as constituting a single series in which both the negative and positive values of n are used. In the same paper Prof. Thiele gives a modification of Prof. Pickering's formula for use in more precise investigations. As an illustration of the question of the relation between sharp and diffuse series as branches of a single series, Prof. Thiele works out the lines in the spectrum of helium, and he is led to the conclusion that "in spite of the remarkable correspondence of these two series I must therefore (*sic*) deny their unity." The second paper, which we can now only briefly refer to, is that by L. Rummel, read before the Royal Society of Victoria in 1896, November 12 (vol. ix.). The author practically obtained a formula independently but similar to that given by Balmer for computing the wave-lengths of the spectral lines of the alkalis, working out the substances lithium, sodium, potassium, rubidium, and cæsium. In another paper, communicated by the author to the same Society in 1897, June 10 (vol. x.), he gives the result of his investigation on the relationship between the spectra of the alkalis and their atomic weights.

THE VARIABLE STAR η AQUILÆ.—In the *Memorie della Società degli Spettroscopisti Italiani*, Prof. A. Belopolsky describes some preliminary researches which he has made with respect to the motion of the variable star, η Aquilæ, as determined by movement in the line of sight. Up to the present time he has been able to secure twelve photographs, the duration of exposure in all cases being less than an hour. The measures were made relatively to the solar spectrum, which was superposed on the spectrum of the star with the help of the artificial spectrum of iron. Twelve prominent lines were used, and three systems of readings were obtained; namely, those given by comparing the stellar and solar spectrum, the solar and artificial spectrum, and the stellar and artificial spectrum. By means of a graphical process the author determines the required and the direct displacement.

The following summary gives in tabular form the times of observation, the intervals of time between the minimum and the moment of observation, the radial velocity, and the velocity relative to the sun.

1897.	Mean time Pulkova. h.	Interval from minimum. d. h.	Radial velocity.	Vel. rel. to ☉.
July 10	12	2 14	−4·485	−3·86
11	12	3 14	−4·454	−3·89
12	13	4 15	−3·196	−2·70
13	12	5 14	−2·022	−1·58
17	12	2 10	−3·629	−3·44
21	12	6 10	−1·228	−1·29
22	12	0 6	+0·146	+0·02
25	11	3 6	−4·016	−4·32
25	12	3 7	−3·604	−3·91
26	11	4 8	−2·930	−3·29
30	12	1 2	+1·195	+0·58
Aug. 2	11	4 1	−2·856	−3·65

Plotting the curve of velocities, after the method of Rambaut and Lehmann-Filhés, Prof. Belopolsky finds that the period 7d. 4h. is sufficiently satisfied on the supposition that the changes of the radial velocity are due to orbital movement of the star. A computation of the orbit, after the method described in *Astronomische Nachrichten* (No. 3242), leads the author to the conclusion that the variation of light cannot be attributed to an eclipse, as the time of eclipse ought to take place 2d. 0h. or 5d. 11h. after the minimum, which is not in accordance with the actual facts. This result is interesting in that it tends to corroborate the conclusion arrived at by Dr. W. J. S. Lockyer ("Resultate aus den Beobachtungen des veränderlichen Sternes η Aquilæ," 1897, Dulau and Co., London) in the latest

discussion of all the available observations of this star up to the year 1894 relatively to the form and changes of the light curve.

COMET PERRINE.—We have received a telegram from Prof. Kreutz, Kiel, dated October 18, in which we are informed that Comet Perrine on October 16, at 9h. 38·8m., Lick mean time, appeared of the eighth magnitude, and was situated in R.A. 3h. 36m. 8s. and N.P.D. 23° 13′ 16″. It was observed to have a small tail.

A later telegram, dated October 19, gives the following position and magnitude: October 18, 11h. 31·1m., Pola mean time, R.A. 3h. 25m. 31s., N.P.D. 20° 34′ 44″, magnitude 10·0.

HEREDITARY COLOUR IN HORSES.

MY attention has been drawn to a collection of data on the hereditary transmission of colour in horses, which appeared in the last Christmas Number of the *Horseman*, a newspaper published in Chicago, U.S. It is signed with the pseudonym of "Tron Kirk." I corresponded with the author, who is noted for his knowledge of horse-breeding, and he assures me of their substantial correctness. His statistics are chiefly obtained from breeders' catalogues, and, however valuable in other ways, fail seriously through the great disproportion which must exist between the number of the different sires and that of the dams, a single sire in the polygamatous arrangements of a stud begetting a numerous offspring from nearly as many dams. It is stated that no less than 3100 foals were begotten by only 46 different bay sires, or more than an average of 67 foals by each sire. Now the number of offspring of the 16 different forms of colour union registered in Table I. is, with one exception, by no means large; in 9 cases it is less than 100, and in one of these it is only 6. Consequently the prepotencies, or the reverse, of individual sire will fail to balance each other, and are sure to produce anomalous results.

The data I propose to use are those contained in Table I.; they have been extracted from the memoir in the *Horseman*, but are newly arranged both in line and column. I have omitted grey altogether, no grey stallions being recorded, and all the grey foals coming from grey dams.

TABLE I.

No. of observations	Colour of		Per cents. of colours in offspring				Totals
	Dam	Sire	Chestnut	Bay	Brown	Black	
68	Ches	Ches	100	—	—	—	100
1900	Bay	Bay	10	81	6	3	100
19	Brn	Brn	—	42	52	5	99
25	Blk	Blk	—	4	28	68	100
407	Ches	Bay	33	61	4	2	100
366	Bay	Ches	30	63	3	4	100
52	Ches	Brn	—	86	11	2	99
69	Brn	Ches	16	65	10	9	100
72	Ches	Blk	6	76	15	3	100
57	Blk	Ches	30	40	—	30	100
221	Bay	Brn	1	79	14	6	100
450	Brn	Bay	6	66	18	10	100
156	Bay	Blk	3	60	30	7	100
268	Blk	Bay	7	53	16	24	100
55	Brn	Blk	—	22	38	40	100
6	Blk	Brn	—	16	50	33	99

My first inquiry was to determine whether the sire or the dam exercises the larger influence in transmitting his or her own colour to the offspring, this being a point on which different breeders express contradictory opinions. The truth in the present instance is easily arrived at by means of Table II., where the percentages of the offspring who resemble their Dam are compared with those that resemble their Sire. This is done in each several pair of "reciprocal" unions, such as that which consists of [*Dam*, bay—*Sire*, brown]; and of [*Dam*, brown—*Sire*, bay]. The table shows a total of 394 cases of resemblance

TABLE II.

Colour of the Dam	Per cent. of offspring who in colour resemble their Dam						Totals
	Sire	p.c.	Sire	p.c.	Sire	p.c.	
Chestnut ...	Bay	33	Brn	0	Blk	6	39
Bay	Ches	63	Brn	79	Blk	60	202
Brown ...	Ches	10	Bay	18	Blk	38	66
Black ...	Ches	30	Bay	24	Brn	33	87
							394

Colour of the Sire	Per cent. of offspring who in colour resemble their Sire						Totals
	Dam	p.c.	Dam	p.c.	Dam	p.c.	
Chestnut ...	Bay	30	Brn	16	Blk	30	76
Bay	Ches	61	Brn	66	Blk	53	180
Brown ...	Ches	11	Bay	14	Blk	50	75
Black ...	Ches	3	Bay	7	Brn	40	50
							381

in the one set, to 381 in the other; in short, it proves that the potency of the dam in transmitting colour is substantially the same as that of the sire.

The intention of the second inquiry was to test an important part of my recent theory on "The average contribution of each several ancestor to the total heritage of the offspring" (*Proc. R. Soc.*, June 3, 1897, and NATURE, July 8, 1897). According to this theory each of the two parents contributes *on the average* one quarter of the total heritage, each of the four grandparents one sixteenth, and so on. If this be strictly true, and if the potency of the two sexes be the same, one half of the varied offspring from the [bay—bay] pairs added to one half of those of an equal number from the [brown—brown] pairs, would be identical in character with the same number of the offspring of [bay—brown], also with those of [brown—bay]. The same holds true for every other form of union between sires and dams of different colours. However, the statistics in Table I. run so roughly that this particular comparison would fail to lead to trustworthy results. It is true that reciprocal unions are seen to give rise to similar results in [chestnut and bay], to fairly similar ones in both [bay and brown], and in [brown and black], and to not very dissimilar ones in [bay and black], but each of the two remaining sets is incongruous. Moreover, the figures contained in them run wildly; thus in the line [black—chestnut] the sequence of the numbers, 30, 40, 0, 30, is a statistical impossibility, and in the line [chestnut—brown] the sequence of 0, 86, 11, 2, is very suspicious. It is obvious that a more trustworthy interpretation of the true state of the case might be deduced from these rude data, if the four entries in each line could be appropriately consolidated so as to be expressed by a single number. It occurred to me that a good way of doing so would be to determine the amount of red pigment corresponding to each entry in the same line, and to sum those amounts. Guided at first by the judgment of the eye, and afterwards by observing how nearly each successive assumption satisfied the observed facts, I fixed on the following allowances, supposing full red pigmentation to count as 1. For chestnut, 0·8; for bay, 0·7; for brown, 0·4; and, recollecting the considerable amount of red pigment in the blackest human hair, I fixed the allowance for black at 0·1.

There are twelve equations in which these four values appear; so if all are fairly well satisfied by the above assumptions, we may rest content. I did not take pains to have the red pigment

extracted and weighed from equal quantities of hair of the four several colours, because there is room for doubt as to the medium tints of those colours, and because those mediums may not be precisely the same in America as here. It seemed better to work the problem backwards, in the way to be easily understood from the following example. The [bay—bay] unions, according to Table I., produce 10 per cent. of chestnut offspring, 81 per cent. of bay, 6 per cent. of brown, and 3 per cent. of black. Therefore the quantity of red contained in each hundred offspring of [bay—bay] parents should be reckoned at

$$10 \times 0{\cdot}8 + 81 \times 0{\cdot}7 + 6 \times 0{\cdot}4 + 3 \times 0{\cdot}1 = 67{\cdot}4 \text{ units.}$$

Since this is the amount of red contributed by the *two* bay parents, the contribution from either bay parent singly will be only half as much, or 33·7.

Similarly the contribution of red from a single chestnut parent will be found to be 40·0; of a brown, 25·3; and of a black, 10·4. Consequently the quantity of red in each hundred offspring of [bay and brown] unions will, according to the theory, be reckoned at

$$33{\cdot}7 + 25{\cdot}3 = 59 \text{ units.}$$

This number has been entered in its proper place in Table III. as the "calculated" value, and may there be compared with the "observed" value obtained from the reciprocal unions of [*Dam*, bay—*Sire*, brown], and of [*Dam*, brown—*Sire*, bay]. Now, the former of these is seen in Table I. to have produced 1 per cent. of chestnut, 79 per cent. of bay, 14 per cent. of brown, and 6 per cent. of black, yielding by the method just described, 62·3 units of red; by a similar treatment the latter of these unions, namely [*Dam*, brown—*Sire*, bay] will be found to yield 59·2 units. The mean of 62·3 and 59·2 being 60·75, that is 61 when reckoned to the nearest integer, is also entered in a separate column in Table III.

TABLE III.—*Amount of Red in Offspring, observed and calculated.*

No. of cases	Offspring of: Dam	Offspring of: Sire	Red observed	No. of cases	Offspring of: Dam	Offspring of: Sire	Red observed	Mean observed	Calculated	Differences
407	Ches	Bay	71	360	Bay	Ches	70	70	74	+ 4
52	Ches	Brn	65	69	Brn	Ches	63	64	65	+ 1
72	Ches	Blk	64	57	Blk	Ches	55	60	50	− 10
221	Bay	Brn	62	450	Brn	Bay	59	61	59	− 2
156	Bay	Blk	57	268	Blk	Bay	52	54	41	− 13
55	Brn	Blk	35	6	Blk	Brn	35	35	36	+ 1

The general result of the comparisons is that calculation agrees with observation as closely as the rudeness of the statistics could lead one to expect. The average error between each of the six calculations and the corresponding means of each of the six pairs of reciprocal observations is about 5 per cent., while the greatest error barely exceeds 10 per cent. I therefore consider these results to corroborate that part of my theory of inheritance which they were intended to test.

Permit me to take this opportunity of removing a possible misapprehension respecting the scope of my theory. That theory is intended to apply only to the offspring of parents who, being of the *same variety*, differ in having a greater or less amount of such characteristics as any individual of that variety may normally possess. It does *not* relate to the offspring of parents of different varieties; in short, it has nothing to do with hybridism, for in that case the offspring of two diverse parents do not necessarily assume an intermediate form.

I am further desirous of drawing attention to an absurd error in my recent memoir quoted above, through the accidental transposition by me of the words Dam and Sire in the side columns of the Table II. of that memoir (which Table was constructed out of the Table I. that preceded it). The result was that the potency of the Dam to that of the Sire in transmitting colour was stated to have come out as 6 to 5, whereas the fact is the exact converse, namely, as 5 to 6. I ought to add that this strange blunder, which was detected and obligingly pointed out to me by two separate correspondents, had no effect upon the general conclusions of the memoir, because the ratio of 6 to 5 was treated as an insignificant disproportion, and the two sexes were dealt with on equal terms.

FRANCIS GALTON.

AERONAUTICAL ASCENTS FOR MEASURING THE ELECTRICAL FIELD OF THE AIR.

ON September 11, M. Lecadet, astronomer of the Lyons Observatory, made his fifth aeronautical ascent for testing the electricity of the air at high altitudes. This system of observation was invented by Dr. Exner, a member of the Vienna Academy of Sciences, who sent into the atmosphere a balloon directed by Lechner, on June 6, 1885. The balloon reached only an altitude of 600 metres, and the results of the reading, taken by an inexperienced observer, were of no value.

On September 27, 1892, M. Andrée, director of the Lyons Observatory, determined to ascend himself, with M. Lecadet as his assistant. The ascent ended in a total wreck.

In the following year M. Lecadet made two ascents at Meudon with the Government balloon, after having procured permission from the War Office. In the first trip (August 1893) the balloon was conducted by Captains Paul Renard and Julian, and ascended only to a very moderate altitude. The second experiment took place on August 9, and only one officer, Captain Hugot, was sent up with M. Lecadet. The experiments showed that the electrical field of the air gradually diminished, though the measures were executed with the cumbersome instrument designed by Dr. Exner.

In the following month, in September 1893, two ascents were made from Tempelhof, with the balloons of the Prussian Government, by Dr. Bornstein, a member of the Berlin Society for Aerial Navigation. The results were about the same as those observed by Lecadet.

After carrying out these experiments, M. Lecadet devised a new instrument. The readings are taken with an Exner electrometer, but instead of being placed in equilibrium with the electricity of the air by two jets of water at a vertical distance of five metres from each other, the effect is obtained by two cylinders of paper impregnated with nitrate of lead, which, once being lighted, are burning without flame. They are placed each to the extremity of one single wire, whose length can be varied at will. The apparatus weighs 3 or 4 kilogs., instead of at least 50. Many experiments made at Lyons Observatory proved that there was no danger of ignition of the gas issuing from the balloon, but the Minister of War declined the proposal of authorising ascents from its balloon arsenal.

The first experiment with the new system was tried at Lyons a few months ago with M. Boulade, an able local aeronaut. The experiments were conducted with great care and success up to 1000 metres, and the electric field of the air was again found to gradually decrease.

As Lyons is in close vicinity with the Alpine district, it was considered unsafe to try an ascent at a great altitude under these circumstances. M. Lecadet therefore went to Paris, and secured the assistance of M. Besançon, a member of the International committee for the *Ballons Sondes*. The balloon had a capacity of 1700 cubic metres; it was a new one, in China silk. There was no cloud in the sky, and only some vapour near the earth's surface. The two aeronauts reached an altitude of 4200 metres. The wind was rather strong, as in five hours they ran about 220 miles in a W.S.W. direction. They landed at Aubigne (Marne et Loire) in a regular gale, but escaped unhurt, owing to the use of a special grapnel and tearing-rope invented by M. Besançon.

The readings taken were very numerous—about 300—and the results are a continuous decrease of the electric field from the level of the ground. Through the courtesy of M. Lecadet, we are enabled to give the summary of results, which will be laid before the Academy of Sciences by M. Mascart when all the calculations have been completed, which will require some time.

Altitude	$\frac{\Delta v}{\Delta x}$
Close to the earth	120 volts
1000 metres	39 "
4200 "	11 "

The results show that at about 6000 metres the $\frac{\Delta v}{\Delta t}$ will be almost 0. Then the balloon will have reached the surface of electrical equilibrium.

If the electrical tension at this altitude is supposed to be 0, the potential of the earth $\Sigma \frac{\Delta v}{\Delta x} = -160{,}000$ (about). The eminent director of the French Meteorological Service has expressed his satisfaction at the results obtained, and has suggested

that another experiment should be tried in winter time, with clear and cold weather. He has also promised to direct to these experiments the attention of the Parisian Committee for Scientific Aeronautical Ascents. But it is likely that funds will be supplied by Lyonnese scientific men and capitalists. The expense of this ascent was borne by M. Jacquemet, a country gentleman, whose estate is in the vicinity of the Lyons Observatory. It is but fair to add that these all-important investigations should not be conducted with electrical kites, as used so cleverly in America for obtaining the temperature of the air. W. DE FONVIELLE.

BOTANY AT THE BRITISH ASSOCIATION.

THE business of the Section was opened by the presentation of reports (1) on the preservation of plants for exhibition, and (2) the fertilisation of the Phæophyceæ. Since the interim report on the preservation of plants (B.A. Report, 1896), the Committee have continued their inquiries and investigations, and the result of their work has been largely to confirm the statements contained in their previous report. They express the opinion that alcohol on the whole yields the best results as a liquid medium for the preservation of specimens. Drying in sand, in cases where the specimens are not intended to be handled, is recommended as a method by which admirable results may be obtained.

The Committee appointed to conduct experiments on the fertilisation of the Phæophyceæ presented an interim report on the favourable progress of the work. In the course of the meeting a cablegram was received by Prof. Farmer, the Chairman of the Committee, from Mr. J. L. Williams, of Bangor, announcing the discovery of motile antherozoids in the genera *Dictyota* and *Taonia.*

PHYSIOLOGY.

A preliminary account of a new method of investigating the behaviour of stomata, by Francis Darwin, F.R.S. The instrument used by the author in the present researches is a hygroscope depending for its action on the extreme sensitiveness to watery vapour of certain substances. The best material consists of thin sheets of horn treated in a special manner, and known as "Chinese sensitive leaf." The other is what is used for the toys described as "fortune-telling ladies," "magical fish," &c. When either of these membranes is placed on a damp surface it instantly curves with the concavity away from the source of moisture. If one end of a strip of the material is fixed to the lower surface of a block of cork, and is placed on the stomatal face of a leaf, it is clear that only the free end can rise. It is on this principle that the hygroscope is constructed, the angle to which the hygroscope tongue rises being a rough indication of the degree of transpiration. Thus on a leaf having stomata only below, the index of the hygroscope remains at zero on the upper surface of the leaf, while on the lower side it instantly rises to an angle varying with the condition of the stomata. If they are widely open the angle will be 30° or 40° to a horizontal line; if the stomata are closed the reading will be zero on both surfaces of the leaf. The author is engaged in a general investigation of the behaviour of the stomata under varying conditions.

Some considerations upon the functions of stomata, by Prof. C. E. Bessey. Prof. Bessey summarily reviewed the structure of stomata, and discussed the needs of aquatic, terrestrial, and aerial plants as to their getting of food, and the means by which they resist the drying of their tissues. The author concludes (1) that one of the functions of stomata is the admission of carbon dioxide to the chlorophyll-bearing tissues of the plant, for use in the formation of the carbohydrates. (2) That the loss of water by terrestrial plants was originally hurtful, and is so now in many cases. (3) That if plants have utilised this constant phenomenon, it is for the supply of food matters of secondary importance, as the salts in solution in the water of the soil.

Report upon some preliminary experiments with the Röntgen rays on plants, by Prof. G. F. Atkinson. The experiments were conducted for the purpose of testing the effect of the Röntgen rays on plants exposed during a considerable period of time. After a few preliminary experiments with leaves of *Caladium*, flowers of *Begonia*, and various seedlings exposed for one to ten hours, in which no perceptible injury resulted, a run was made in which several seedlings were exposed for a total of forty-five hours in a dark room. The plants behaved exactly as plants grown in a dark room. On removing the seedlings from the dark room they all became slowly green, but those which were uuder the influence of the Röntgen rays recovered the green colour more slowly; this suggests that the rays may have a slightly injurious effect on the chloroplastids. No other influence could be detected. Experiments were made on the absorption of the Röntgen rays by plants. Species of *Mucor*, Bacteria, and *Oscillatoria* were exposed to the action of the rays, but no influence was exerted on their growth or movement.

One morning session was devoted to a joint discussion with Section I, on the chemistry and structure of the cell. Prof. Meldola contributed an important paper on the rationale of chemical synthesis, and Prof. J. R. Green gave an account of his investigations on the existence of an alcohol-producing enzyme in yeast.

Dr. Armstrong exhibited a series of diagrams, which showed in a comparative manner the principal results of fifty years experimenting on the growth of wheat at Rothamsted.

Dr. Saunders, the Director of the Dominion Experimental Farms, contributed a paper on the results of some experiments in cross-fertilisation. He dealt chiefly with the efforts that had been made to introduce fruits suitable for the climate of the North-west Territories of Canada. Experiments were described on hardy apples from Northern Russia, and other regions; and Dr. Saunders referred to two forms of Siberian crab-apples from which promising crosses have been obtained. The author expressed the opinion that it will be possible in a few years to supply the North-west Territories with apples capable of withstanding the severe climate.

On the structure of a hybrid fern and its bearings on hybridity in general, by Prof. J. B. Farmer. This paper dealt with the characters, both macro- and micro-scopic, of *Polypodium Schneideri*, a hybrid between *P. aureum* and *P. vulgare*, var. *elegantissimum*. The facts elicited from a study of this plant were compared with those of analogous cases, and served as the basis for a discussion as to the nature of hybrids and of hybridisation.

THALLOPHYTA.

Prof. Marshall Ward (President) contributed a paper on *Stereum hirsutum*, a wood-destroying fungus.

The author cultivated this fungus from the spores, on sterilised wood blocks, and traced the action of the mycelium week by week on the elements of the wood. He obtained spore-bearing hymenia, and worked out the life-history very completely. Hartig, in his "Zersetzungserscheinungen des Holzes," examined the wood-destroying action of this fungus, but used material growing in the open, and therefore not pure. Brefeld attempted its culture, but failed to make it develop any fructification or spores.

The fertile hymenium arises in about three to four months. The author examined the development very thoroughly, and referred to discrepancies in the existing descriptions. The details of its destruction of the wood were fully described; the fungus delignifies the inner layers of the walls of the wood-elements, and in three months' cultures and upwards these turn blue in chlor-zinc-iodine, and are shown by other reagents to undergo alteration to cellulose-like bodies before their final consumption by the fungus.

On the mycelium of the witches' broom of Barberry caused by *Æcidium graveolens*, by Prof. P. Magnus. The author of the paper criticised the work of Dr. Eriksson on this parasitic fungus. The intracellular mycelium, described by Eriksson in the cambium cells of the host-plant, is regarded by Magnus as the plasmolysed cell contents. The latter author finds that the mycelium is always intercellular, and that it puts out branches into the cells of the pith, medullary rays, and cortical parenchyma of the host.

The nucleus of the yeast plant, by Harold Wager. In *Saccharomyces cerevisea* the nucleus can be easily demonstrated by careful staining in hæmatoxylin, Hartog's double stain of nigrosin and carmine, or by staining in aniline-water solution of gentian violet. It appears to consist, in the majority of cases, of a homogeneous substance, spherical in shape, placed between the cell-wall and the vacuole. On the whole, it resembles more than anything else the fragmenting nuclei in the older leaf-cells of *Chara*; that is, it consists of deeply-stained granules embedded in a slightly less stainable matrix.

The process of budding in a yeast cell is accompanied by the division of this nucleus into two. The division is a direct one,

and does not take place in the mother-cell, but in the neck joining it to the daughter-cell. When about to divide, the nucleus places itself just at the opening of this neck, and proceeds to make its way through it into the daughter-cell, until about half of it has passed through, when it divides completely, and the two nuclei thus formed separate from each other towards the opposite sides of their respective cells.

The nuclei of *Saccharomyces Ludwigii* and *S. Pastorianus* were also described.

The process of spore-formation was observed in *S. cerevisea*. In a cell about to sporulate the nucleus is found in the centre of the cell, and appears to be homogeneous in structure. When the nucleus divides its outline becomes irregular, and the granules arrange themselves in the form of a short rod surrounded by the other portion of the nucleus, which stains differently and appears to form a structure of the nature of a spindle. The granules separate into two groups, and each group becomes a nucleus. The two nuclei thus formed again divide, and four nuclei are produced, each of which becomes the nucleus of a spore. A small quantity of protoplasm accumulates round each nucleus, spore membranes appear, and four spores are thus formed, standing in the remainder of the protoplasm, from which ultimately the thick spore membranes are produced.

The author referred to the process of nuclear division in spore-formation as probably a simple form of karyokinesis.

A disease of tomatoes, by W. G. P. Ellis. From diseased tomatoes received in August 1896 from Jersey, the associated fungi and bacteria were isolated and cultivated on nutrient gelatine, and the mycelium was traced in sections of the fruits. On removing the fruit skin with carefully sterilised instruments the mycelium within the fruit formed in a short time the well-known sporangiophores of *Mucor stolonifer*. Though late in the season, infection of sound plants at the University Botanic Gardens, Cambridge, from pure cultures caused a disease resembling that of the fruits received in August and September from the grower. Experiments are in progress to determine (1) whether the fungi obtained, other than *Mucor stolonifer*, cause disease, and (2) the site of infection.

Note on *Pleurococcus*, by Dorothea F. M. Pertz. Cultures of *Pleurococcus* in nutritive solutions were made during the winter months, from November to April. They did well in Knop's solution, ·2 per cent., in sterilised glass dishes and flasks, which were placed in different situations: in the laboratory, in a greenhouse, and out of doors.

Separate clusters of *Pleurococcus* in hanging drops of the same solution were also observed as continuously as possible. These drops were suspended in carefully sterilised moist chambers, which were kept for several weeks, in one case for two months.

The chief difficulties met with were, first, to obtain the *Pleurococcus* in absolutely pure condition, and then to keep it sufficiently aërated without running any risk of making the culture impure. Both the "globular sporangia" and those of "elongated or quadrangular form," observed by Chodat, occurred frequently, and they seem undoubtedly to be produced by the transformation of normal *Pleurococcus* cells. Individual sporangia were repeatedly selected for special observation, and the process by which they break up into separate spores was noted at all its stages.

The filamentous form described by Chodat never occurred.

Prof. Farmer, in referring to Miss Pertz' experiments, announced that he had succeeded in obtaining the filamentous form of Chodat from *Pleurococcus* cells.

Prof. Crookshank read a paper on *Streptothrix actinomycotica* and allied species of *Streptothrix*, and Prof. Macallum, of Toronto, contributed a paper on the origin of intracellular organs.

VASCULAR CRYPTOGAMS AND PHANEROGAMS.

The gametophyte of *Botrychium virginianum*, by E. C. Jeffrey. The author's researches were conducted on prothallia of *Botrychium* obtained from several localities in the province of Quebec and other parts of Canada.

The gametophyte of *B. virginianum* is of flattened oval shape, 2–18 mm. in length and 1·5–8 mm. in breadth. The middle of the upper surface is occupied by a well-defined ridge which bears the antheridia. The archegonia are found on the declivities which slope away from the antheridial ridge. The lower part of the prothallium is composed of yellow tissue rich in oil, the upper portion, on which the sexual organs are situated, is white in colour and free from oil. An endophytic fungus, probably a *Pythium*, occurs in the oily tissue. The antheridia originate behind the growing-point from a single superficial cell. The spermatozoids are large in size, but otherwise resemble the ordinary fern type. This development appears to agree closely with that described in the Marattiaceæ and Equisetaceæ. A young archegonium consists of three cells: the most external gives rise to the neck, the middle cell to the neck-canal-cell and the ventral cell, and the internal cell constitutes the basal cell. The first division of the oospore is across the long axis of the archegonium, the next division is parallel to the long axis of the prothallium, and the third cross-wall is in the transverse direction of the prothallium and at right angles to the other two. The organs appear very late, and only after the embryo has attained a large size.

Remarks on changes in number of sporangia in vascular plants, by Prof. F. O. Bower, F.R.S. Comparison shows that in certain cases a progressive increase in number of sporangia has taken place, in others a decrease. The changes may be classified as follows:—

Increase in Number of Sporangia.

Directly { (*a*) by septation of sporangia.
(*b*) by interpolation of sporangia.

Indirectly { (*c*) by continued apical or intercalary growth of the part bearing the sporangia, with or without branching.
(*d*) by branchings in the non-sporangial region

Decrease in Number of Sporangia.

Directly { (*a*) by fusion of sporangia.
(*b*) by abortion of sporangia.

Indirectly { (*c*) by reduction or arrest of growth or branching of part bearing the sporangia.
(*d*) by suppression of branchings in the vegetative region, resulting in fewer sporangial shoots.

The author pointed out that the physiological condition of the plant during development may largely determine the greater or less prominence of any one factor; he maintained that an analytical study, such as the above, may afford assistance in solving the problem of the origin of homosporous Pteridophyta.

On spermatozoids in *Zamia integrifolia*, by H. J. Webber. Mr. Webber gave a short account of his recent discovery of the existence of large multiciliate spermatozoids in the pollen-tube of *Zamia integrifolia*, a cycad which he investigated in Florida. The facts brought forward by the author of the paper were of exceptional interest; he described the development of an unusually large antherozoid from each of the daughter-cells formed by the division of the generative cell in the pollen-tube, each antherozoid being encircled by a spirally disposed ciliate band which the author believes to be developed from the fragments of a centrosome-like body. Mr. Webber observed the discharge of the antherozoids from the pollen-tube, and followed the passage of the motile male-gamete into the archegonium. "The entire antherozoid swims into the archegonium, passing between the ruptured neck-cells." Several antherozoids commonly enter each archegonium, but only one of them takes part in fecundation. The method of antherozoid formation in *Zamia* is regarded as similar to that in *Cycas* and *Ginkgo*.

Prof. Campbell gave an account of some recent work on the genus *Lilæa*, a member of the Juncaginaceæ, and Prof. Coulter read a paper on the life-history of *Ranunculus*. The formation of endosperm prior to fertilisation, and other points of interest in connection with reproduction and embryogeny, were dealt with by these authors.

NATURAL HISTORY, &c.

On the chimney-shaped stomata of *Holacantha Emoryi*, by Prof. Bessey. This prickly leafless shrub, known as the "Sacred Thorn," "Crucifixion Thorn," &c., is a native of the arid regions of Southern Arizona. It possesses remarkable breathing pores, which are evidently designed to enable the plant to obtain carbon dioxide, while at the same time preventing the loss of water from its interior tissues. The epidermis is extremely thick, and the stomata have long chimney-shaped openings above them, terminating in hollow papillæ, which project some distance above the surface.

Prof. Bessey also contributed a paper on the distribution or the native trees of Nebraska.

Messrs. Pound and Clements presented a communication on the vegetation-regions of the Prairie Province. A portion of the paper was devoted to a critique of the treatment accorded by various authors to the floral covering of the North American continent. The authors endeavoured to demonstrate the integrity of the Great Plains as a single vegetation province, and summarised the most salient floral features.

Mr. F. E. Clements also contributed a paper on the zonal constitution and disposition of plant formations.

On the species of *Picea* occurring in the North-Eastern United States and Canada, by Prof. D. P. Penhallow. Since the time of Pursh, the validity of the red spruce as a distinct species has been generally denied by systematic botanists. In 1887 Dr. George Lawson maintained that the red and black spruces are distinct species. This view has been sustained during the last year by Britton in his illustrated "Flora of North America." Prof. Penhallow's studies have led him to the conclusion that there are abundant reasons for the separation of *Picea rubra* as a distinct species. Incidentally, attention was directed to a form of the white spruce characterised by its fœtid odour, and its strongly glaucous, rigid and often cuspidate leaves, which are commonly broadened at the base. The name of *fœtida* is suggested for this form.

PALÆOBOTANY.

Notes on fossil Equisetaceæ, by A. C. Seward. The author of these notes gave examples of the difficulty of distinguishing between certain Palæozoic fossils referred to *Equisetites* and the genus *Calamites*. He expressed the opinion that the fused leaf-segments usually regarded as characteristic of *Equisetites* may not afford a trustworthy distinguishing feature. Reference was made to *Equisetites Hemingwayi*, Kidst, from the English coal-measures as a species of which the precise affinity remains doubtful. Evidence was brought forward that the Jurassic species originally described by Bunbury as *Calamites Beanii*, and referred by some authors to the Monocotyledons, should be referred to *Equisetites*. Another Jurassic species, *Equisetites lateralis*, was also described, and reasons were given for regarding this species as a true *Equisetites* rather than a form of *Phyllotheca* or *Schizoneura*.

On Monday afternoon, August 23, a lecture was delivered by Mr. A. C. Seward, on fossil plants. The lecturer gave illustrations of the bearing of Palæobotany on the problems of plant evolution, and special reference was made to the genera *Ginkgo*, *Bennettites*, *Lyginodendron*, and others.

ON OBTAINING METEOROLOGICAL RECORDS IN THE UPPER AIR BY MEANS OF KITES AND BALLOONS.[1]

A KNOWLEDGE of the physical conditions which prevail up to the highest cloud levels, five to nine miles above the earth, is of great importance to meteorologists, who until recently have been studying principally the conditions existing near the floor of the aerial ocean, and from that standpoint have endeavoured to formulate the laws which control the pressure, temperature, humidity, and currents in the great volume of air above them. Continued and systematic observations on mountains in different parts of the world latterly have contributed much to our knowledge of the approximate conditions of the atmosphere, under various circumstances, up to a height of more than three miles above sea-level; but the mass and surface of the mountain, even when this is an isolated peak, influence very considerably the surrounding air. Recognising, then, the value of the determination of the true conditions of the free air, let us consider what methods are available for this investigation, which must necessarily be sporadic and of shorter duration than if conducted on mountains. In the writer's opinion, free balloons with aeronauts cannot be recommended on account of the large cost in money, and sometimes the loss of life, which attend their frequent use, while without artificial aids to respiration the aeronaut cannot rise much above five miles. Captive balloons, with observers, have been used in England, and more recently, with self-recording instruments, in Germany; but their height is limited to about two thousand feet by the weight of the lifted cable, and a wind which is sufficient to overcome their buoyancy drives them down and occasions violent shocks to the suspended instruments. A kite-balloon on trial in the German army is intended to combine the advantages of a kite and a balloon; but the cost and the moderate height attainable render it inferior to the simple kite for meteorological researches, except during calms which sometimes occur at the earth's surface, but rarely extend aloft.

There remain kites and unmanned balloons, both recording graphically and continuously the chief meteorological conditions, and these it is my intention to describe in this paper. The recent development of the kite for meteorological purposes has taken place in the United States, while the use of the automatic balloon for obtaining data at very great altitudes has hitherto been confined to Europe.

Kites appear to have been first applied in meteorology by Alexander Wilson, of Glasgow, who in 1749 raised thermometers attached to the kites into the clouds (*Trans. Roy. Soc. of Edinburgh*, vol. x. part ii. pp. 284–286). Three years later, Franklin performed in Philadelphia his celebrated experiment of collecting the electricity of the thunder-cloud by means of a kite (Sparks's "Works of Benjamin Franklin," vol. v. p. 295). Although kites have served a variety of purposes, their first systematic use in meteorology was probably in England between 1883 and 1885, when E. D. Archibald made differential measurements of wind velocity by anemometers raised by kites fifteen hundred feet (NATURE, vol. xxxi.). In 1885, A. McAdie repeated Franklin's kite experiment on Blue Hill, using an electrometer (*Proceedings* of the American Academy, vol. xxi. pp. 129–134), and in 1891 and 1892 made simultaneous measurements of electrical potential at the base of Blue Hill, on the hill, and several hundred feet above it with kites as collectors (*Annals. Astr. Obs. Harv. Coll.*, vol. xl. parts i. and ii., Appendices A and C). The invention of light-weight self-recording instruments made it possible to obtain graphic records in the air by means of kites, and after W. A. Eddy had introduced tailless kites into America, and had attached a minimum thermometer in 1891 (*Am. Met. Journal*, vol. viii. pp. 122–125), a thermograph reconstructed of lighter materials by S. P. Fergusson, of the Blue Hill Observatory, was raised on August 4, 1894, 1430 feet above the hill (*ibid.* vol. xi. pp. 297–303). It was no doubt the first instrument, recording continuously and graphically, to be lifted by kites, and it permitted simultaneous observations to be obtained in the free air and near the ground. This method of studying the meteorological conditions of the free air has ever since been in regular use at the Blue Hill Observatory; but notwithstanding the general interest which has recently been aroused in kites, it is not known by the writer that meteorographs have elsewhere been raised by them.

The details of the work, as now carried on at Blue Hill, are as follows. The kites, which have no tails, are of Eddy's Malay, or of Hargrave's cellular types, the former presenting a convex surface to the wind, and the latter two pairs of superposed planes, each pair being connected by side planes. In addition to the two leading kites, others are attached by independent cords to various points of the line, which is a steel music wire, 0·033 inch in diameter, having a tensile strength of three hundred pounds, and weighing fifteen pounds per mile. The meteorographs are composed mostly of aluminium and weigh less than three pounds each, the one constructed by J. Richard, of Paris, recording on a single clock cylinder atmospheric pressure, air temperature, and relative humidity (*La Nature*, 8 Février, 1896), while that made by Mr. Fergusson similarly records wind velocity and air temperature. One of these instruments is hung to the wire between two kites, in order to ensure its safety in case of breakage of the wire or of one kite, or the failure of the wind to support the latter. The wire is coiled upon the drum of a windlass, which may be turned by two men, and a measuring device registers the amount of wire uncoiled, while the angular elevation of the meteorograph, when not hidden by clouds, is observed from time to time with a surveyor's transit at the windlass or at the ends of a base line. From these data, or from the barometric record, the altitude of the meteorograph is calculated. Kites may be flown in all kinds of weather, whenever the wind's velocity is between fourteen and thirty-five miles an hour: and since on Blue Hill the average velocity is more than eighteen miles an hour, days are frequent when flights are possible.

Probably the greatest elevation yet attained by kites, and certainly the highest level to which kites have lifted a meteorograph, is 8740 feet above Blue Hill. This was accomplished, October 8, 1896, by the aid of nine kites, having a total area of 170 square feet, which gave a maximum pull at the ground of

[1] By A. Lawrence Rotch. (Reprinted from the *Proceedings* of the American Academy of Arts and Sciences, vol. xxxii. No. 13, May 1897.)

about 100 pounds (*Science*, November 13, 1896, p. 718). The meteorograph remained during several hours higher than a mile, and good records of the indications of the barometer, thermometer, and hygrometer were brought down. More than one hundred records of atmospheric pressure, temperature, and relative humidity of the air, or wind velocity, at intermediate heights up to the extreme altitude just stated, have been obtained, and they are being discussed for publication with the Blue Hill observations for 1896, in the "Annals of the Astronomical Observatory of Harvard College." A few general conclusions may be mentioned. At the height of about a mile the diurnal changes of temperature in the free air nearly disappear, although in fair weather the days are damper than the nights. "Cold and warm waves" commence in the upper air, as is proved by the temperature decreasing faster than normal, or even increasing abruptly, with altitude before the fall or rise of temperature commences at the earth's surface. Several ascents through clouds have shown the air above them to be usually warmer and drier than the air below. Kites furnish a ready and accurate method of measuring the heights of certain low and uniform clouds, which could not easily be measured otherwise in the day-time. It is interesting to note that this method was used by Espy, about 1840, to verify his calculations of the height at which condensation begins ("Philosophy of Storms," 1841, p. 75). Changes of wind direction in the different air strata are determined from the azimuths of the kites, and this change sometimes amounts to 180°. The wind velocity usually increases with altitude, and vertical currents commonly prevail near cumulus clouds. During high flights the wire is strongly charged with electricity, but no measurements of its kind or potential have lately been attempted.

The writer is glad to acknowledge his indebtedness to his assistants, Messrs. Clayton and Fergusson, who have devised and constructed improved kites and apparatus, and during his absence have taken entire charge of the work. To them and to another assistant, Mr. Sweetland, is largely due the success which has been attained in this novel branch of research. For still higher ascents there will be required a steam engine to operate the windlass, and a meteorograph with a lower pressure scale. With these appliances, for whose purchase a grant has been asked from the Hodgkins Fund of the Smithsonian Institution, it is probable that records can be obtained three miles above Blue Hill, and possibly higher.

To reach much higher altitudes, unmanned free balloons, or "ballons sondes" as they are called, have been considerably used both in France and Germany. These balloons, which carry self-recording apparatus, rise until equilibrium is attained in the rarefied air. When they lose their buoyancy and fall to the earth, most of them have been recovered, with the instruments and records uninjured, by the senders, who have been notified by the finder of the place of descent, which is often at a great distance from the starting point. The altitudes are calculated from the barometric pressure, according to Laplace's formula, but the impossibility of knowing the mean temperature of the whole mass of air makes the determination inexact. Theoretically, in order to ascend ten miles above the earth, where the pressure is about one-ninth that at the earth, the balloon must lift itself from the ground when one-ninth filled with gas. Therefore a relatively large balloon is required, and its initial velocity of ascent is great, because it is found advantageous to fill the gas-bag completely. The greatest difficulty has been to protect the thermometers from insolation, and to ensure records being made, notwithstanding the great cold to which the instruments are exposed.

The first systematic experiments of the kind were made in Paris, in 1893, by G. Hermite, who was later associated with G. Besançon. There have been six high ascents from Paris of the three balloons called *L'Aérophile*. The second one of the name had an envelope of gold-beaters' skin, with a capacity of 6360 cubic feet, which when nearly filled with coal-gas gave an initial lifting power of 235 pounds, in excess of its own weight of 49 pounds, and the instruments and screens, which weighed 12 pounds. With this balloon, in October 1895, at an approximate height of 46,000 feet, a temperature of − 94° Fahrenheit was recorded, which is the lowest noted in a balloon, and probably the lowest natural temperature observed on the earth. The average decrease of temperature was 1° Fahrenheit for 320 feet of height. The instruments used are of the well-known Richard type, and have been tested in a chamber whose pressure and temperature are lowered to the limits which it is expected may be reached by the balloon. They are placed below the balloon in a wicker tube six feet high, lined with silver paper to ward off the sun's rays. It is believed by Hermite, that during the rapid ascent of the balloon the draught of air through the tube is sufficient to neutralise the heating of the enclosed air by the sun. It is admitted that when equilibrium is nearly reached this may not be true, and that the temperature recorded near the highest point may be too high. To avoid freezing of the ink the registration is now made on smoked paper, and to protect the instrument from shocks it is hung by springs in a closed basket, which is itself suspended in the tube already mentioned. An apparatus for obtaining samples of air at high altitudes has been carried by the balloon, but as yet without success, owing to difficulties in hermetically closing the receiver after the air has entered, since mechanically closing the inlet tube and sealing it by heat generated chemically have each proved ineffectual at great heights.

By means of a grant from the German Emperor to the Deutsche Verein zur Förderung der Luftschiffahrt, R. Assmann, A. Berson, and others in Berlin, have been able to carry on an extensive series of meteorological investigations with manned balloons, and also with a captive and a free balloon, both equipped with self-recording instruments. The latter, called the *Cirrus*, of 8830 cubic feet capacity, when inflated with coal-gas had a lifting force of about 290 pounds, besides its envelope weighing 93 pounds, and the meteorological apparatus weighing nearly 6 pounds. This is more complicated than the French instruments, since the registration is photographic, and a continuous ventilation of the alcohol thermometer in Assmann's aspiration apparatus is effected by allowing a weight to drive the aspirator. Even with these precautions, the temperatures are probably too high, and the registration is often defective. There have been seven flights of the *Cirrus*, one of the highest occurring in September 1894, when the unprecedentedly low barometric pressure of about two inches of mercury was recorded, giving a computed height of 60,500 feet. The lowest temperature, which was registered at a somewhat less altitude, was not below − 88° Fahrenheit, giving rise to the supposition that the thermometer was heated by insolation. Hence the average decrease of temperature appears to have been but 1° in 409 feet. This balloon rose from Berlin with the great velocity of about 30 feet per second, and travelled 560 miles in an east-north-east direction at a velocity of 83 miles per hour.

For some time past negotiations have been in progress between the French and the Germans for simultaneous ascents of unmanned balloons at night, using identical instruments, whereby the errors due to insolation, and the discrepancies which might be attributed to different instruments, would be avoided. By this co-operation the simultaneous conditions of the upper air over a wide extent of country can be ascertained, just as these conditions near the earth's surface are daily obtained at the meteorological stations in the different countries. The desired result was brought about by the International Meteorological Conference which met in Paris in September 1896. Resolutions were adopted favouring scientific ascents with manned balloons, as well as simultaneous flights of unmanned registration balloons in the different countries. The successful use of kites at Blue Hill to lift self-recording instruments over a mile into the air, led to expressed desire that similar experiments should be tried elsewhere. An international committee was appointed to carry out these resolutions, consisting of Messrs. de Fonvielle and Hermite for France; Assmann, Erk, and Hergesel for Germany; Pomortzeff for Russia; and the writer for the United States. In accordance with the first-named resolutions, a flight of four manned and four registration balloons occurred in France, Germany, and Russia on the night of November 13–14, 1896. Owing to hurried preparations, only the registration balloon liberated from Paris reached a great height; but in presenting a summary of the results to the French Academy (*Comptes rendus*, vol. cxxiii. No. 22, pp. 918, 961), E. Mascart, the director of the French Meteorological Office, remarks that there is reason to hope that this international co-operation will contribute valuable data to our knowledge of the variations of temperature and wind in the upper atmosphere.

As the American representative of the International Aeronautical Committee, the writer hopes that in America a similar exploration of the high atmosphere with registration balloons will be attempted, and he is now preparing an estimate of the cost to submit to the Trustee of the Hodgkins Fund. Since it should supplement his own researches with kites, he has taken the occasion to bring the subject of free registration balloons to the attention of the Academy.

THE AGENCY OF MAN IN THE DISTRIBUTION OF SPECIES.[1]

AMONG the many influences which, during the last century or two, have been affecting that unstable condition of life which is expressed in the words "the geographical distribution of animals and plants," none has approached in potency the agency of man, exerted both purposely and unwittingly or accidentally.

Natural spread was for centuries the rule. Species dispersed under natural conditions along the line of least resistance. Winged animals and seed were spread by flight and by the agency of winds, and at their stopping-places thrived or did not thrive, according as conditions were suitable or not suitable. Aquatic animals and plants and small land animals and plants were distributed by the action of rivers and streams and by the ocean itself. Wonderful migrations have occurred, commonly with birds, more rarely with other animals; ice-floes and drift-wood have carried animals and plants far from their original habitats, and even volcanic action has taken part in the dispersal of species. Smaller animals, especially molluscs and insects, and the seeds of plants have been carried many hundreds of miles by birds, and lesser distances by mammals.

With the improvement of commercial intercourse between nations by land and by sea another factor became more and more prominent, until in the present period of the world's history the agency of man in the spread of species, taking all plant and animal life into consideration, has become the predominating one. Potentially cosmopolitan forms, possibly even insular indigenes, have by this important agency become dispersed over nearly all of the civilised parts of the globe, while thousands of other species have been carried thousands of miles from their native homes, and have established themselves and flourished, often with a new vigour, in a new soil and with a novel environment.

It is obvious that this agency is readily separable into two divisions—intentional and accidental.

INTENTIONAL IMPORTATIONS.

Since early times strange plants and animals have been carried home by travellers. Conquering armies have brought back with the spoils of conquest new and interesting creatures and useful and strange plants. With the discovery of America and with the era of circumnavigation of the globe such introductions into Europe of curious and useful species, plants in particular, increased many-fold, while with the colonisation of America and other new regions by Europeans there were many intentional return introductions of Old World species conducive to the welfare or pleasure of the colonists. Activity in this direction has been increasing and increasing. Public botanical gardens and many wealthy individuals in all quarters of the globe have hardly left a stone unturned in their efforts to introduce and acclimatise new plants, particularly those of economic importance and æsthetic quality, not failing occasionally, it must parenthetically be said, to establish some noxious weed, or some especially injurious insect; while it is safe to say that probably the majority of the desirable plants of Europe which will grow in the United States have already been introduced, and that there has been an almost corresponding degree of activity in the introduction of desirable plants from the United States into Europe. In all this host of valuable introductions there have been comparatively few which have turned out badly, aside from failures of establishment. The wild garlic (*Allium vineale*), that ubiquitous plant which gives its taste to milk, butter, and even to beef during the spring and summer months in many States, is said to have been intentionally introduced by the early residents of Germantown, Pennsylvania. The water hyacinth (*Piaropus crassipes*), originally grown for ornament in a pond near Palatka, Florida, escaped into the Saint John's River about 1890, and has multiplied to such an extent as to seriously retard navigation and to necessitate Government investigation. The distribution of the orange hawk-weed (*Hieracium aurantiacum*), a dangerous species which has ruined hundreds of acres of pasture land in New York of recent years, was originally aided by a florist as a hardy ornamental plant. The European woad-waxen (*Genista tinctorium*) was early introduced at Salem, Mass., in fact about thirty years after the settlement of the colony. It has apparently not been used as a dye plant, but for garden and ornamental purposes only. During the last few years it has become a noxious weed throughout Essex and the adjoining counties. Standing recently on a rock at Swampscott, the writer was able to see that the country for miles around was coloured a bright yellow with enormous masses of this plant. Similar instances are fortunately rare, and the majority of our noxious weeds have been accidental introductions.

Intentional introductions of animals, however, have by no means resulted as advantageously as intentional introductions of plants, with the exception of the truly domesticated species, such as the horse, ass, cow, sheep, pig, dog, cat, poultry, honey-bee, and silk-worm of commerce. Even with such species, the grazing ranges of Australia have been overrun by wild horses to such an extent that paid hunters shoot them at a small sum per head, and the European rabbit has become a much worse plague on the same island continent.

Intentional introductions of wild species, however, have almost without exception resulted disastrously

At various intervals between 1850 and 1867 a few pairs of English sparrows were introduced into the north-eastern States to destroy canker-worms, and to-day this species is an ubiquitous and unmitigated pest throughout all the austral and transition regions of North America, finding its limit only at the borders of the boreal zone, while the place of the injurious insect it was imported to destroy has been taken by another and worse insect pest which it will not touch.

In 1872 Mr. W. Bancroft Espeut imported four pairs of the Indian mongoose from Calcutta into Jamaica for the purpose of destroying the "cane-piece rat." Ten years later it was estimated that the saving to the colony through the work of this animal amounted to 100,000*l*. annually. Then came a sudden change in the aspect of affairs. It was found that the mongoose destroyed all ground-nesting birds, and that the poultry as well as the insectivorous reptiles and batrachians of the island were being exterminated by it. Injurious insects increased in consequence a thousand-fold; the temporary benefits of the introduction were speedily wiped away, and the mongoose became a pest. Domestic animals, including young pigs, kids, lambs, newly-dropped calves, puppies and kittens, were destroyed by it, while it also ate ripe bananas, pine-apples, young corn, avocado pears, sweet potatoes, cocoas, yams, peas, sugar-cane, meat, and salt provisions and fish. Now, we are told, nature has made another effort to restore the balance. With the increase of insects, due to the destruction by the mongooses of their destroyers, has come an increase of ticks, which are destroying the mongoose, and all Jamaicans rejoice.

The flying-foxes of Australia (*Pteropus* sp) are animals which are very destructive to fruit in their native home. Frequently some well-meaning but misguided person will arrive on a steamer at San Francisco with one or more of those creatures as pets. While it is not probable that any of the flying-foxes will thrive in northern California or, in fact, in austral regions, the experience is too dangerous a one to try, and the quarantine officer of the California State Board of Horticulture has always destroyed such assisted immigrants without mercy.

Less than thirty years ago (in 1868 or 1869) Prof. Trouvelot imported the eggs of the gypsy moth (*Porthetria dispar*) into Massachusetts. The insect escaped from confinement, increased in numbers, slowly at first, more rapidly afterwards, until in 1889 it attracted more than local attention, with the result that in 1890 the State began remedial work. This work has steadily progressed since that time, and the State has already expended something over a half-million of dollars in the effort to exterminate the insect, and it is estimated that one million five hundred and seventy-five thousand dollars more must be used before extermination can be effected.

Contrast with this a single intentional importation which has had beneficial results. The Australian ladybird (*Vedalia cardinalis*) was introduced into California in 1889 with the result of saving the whole citrus-growing industry of the State from approaching extinction through the ravages of the cottony-cushion scale (*Icerya purchasi*). Later importations of the same insect into South Africa and Egypt also resulted beneficially.

We have thus had sufficient experience with intentional importations to enable us to conclude that while they may often be beneficial in a high degree, they form a very dangerous class of experiments, and should never be undertaken without the fullest

[1] Abridged from an address by Dr. L. O. Howard, printed in *Science* of September 10.

understanding of the life-history and habits of the species. Even then there may be danger, as with a new environment habits frequently change in a marked degree.

ACCIDENTAL INTRODUCTIONS.

The agency of man, however, has been more potent in extending the range of species and in changing the character of the faunas and floras of the regions which he inhabits by means of accidental importations.

The era of accidental importations began with the beginning of commerce, and has grown with the growth of commerce. The vast extensions of international trade in recent years, every improvement in rapidity of travel and in safety of carriage of goods of all kinds, have increased the opportunities of accidental introductions, until at the present time there is hardly a civilised country which has not, firmly established and flourishing within its territory, hundreds of species of animals and plants of foreign origin, the time and means of introduction of many of which cannot be exactly traced, while of others even the original home cannot be ascertained, so widespread has their distribution become.

These accidental importations would at first glance seem to have been more abundant with plants than with animals, since the opportunities for the carriage of seed, especially flying or burr-like seed, and especially when we consider the vitality of this form of the plant organism, are plainly manifold, but possibly even this obvious generalisation must be modified in view of the multitudinous chances for free travel, which the smaller insects have under our modern systems of transportation.

The agencies which have mainly been instrumental in the accidental distribution of plants are:

(1) Wind storms. It is obvious that light-flying seeds may be carried many hundreds of miles by hurricanes, and may fall in new regions.

(2) Water. This is a very important agency in the distribution of plants upon the same continent, but less important as affecting intra-continental distribution. Still, they may be carried by this means from one island to another adjoining island, and when lodged in the crevices of the driftwood they undoubtedly travel greater distances.

(3) Birds. Seeds are frequently carried great distances by birds. Many of the larger seeds will germinate after passing through the alimentary canal of a bird, and may thus be eaten at one point and voided with the excrement at a widely distant point. It has been shown, for example, that the local distribution of *Rhus toxicodendron* is greatly affected by the carriage and distribution of the seed in this way by the common crow. Smaller seeds are carried in earth on the feet of birds. Darwin's example of a wounded red-legged partridge which had adhering to its leg a ball of earth weighing 6½ ounces, from which he raised thirty-two plants of about five distinct species, is an evidence of the possibilities of this agency, while his experiment with 6¾ ounces of mud from the edge of a pond which produced 537 distinct plants, an average of a seed for every six grains of mud, is still more conclusive.

(4) Ballast. This is the first of the distribution methods which may be combined under the head of "agency of man." The discharge of earth ballast by vessels coming from abroad has been a notable means of distribution of plants by seed. We have just seen how many seeds may germinate from a very small lump of earth, and the possibilities in this direction of the many thousands of pounds of discharged ballast are very great. In fact, the ballast grounds in the neighbourhood of great cities are invariably favourite botanical collecting spots; they have usually a distinctive flora of their own, and from these centres many introduced plants spread into the surrounding country.

(5) Impure seed. The great industry in the sale of seed which has grown up of late years is responsible for the spread of many plant species, principally, it must be said, undesirable species. Mr. L. H. Dewey says: "It may be safely asserted that more of our foreign weeds have come to us through impure field and garden seeds than by all other means combined."

(6) The packing material of merchandise. The hay or straw used in packing crockery, glassware, or other fragile merchandise, is a frequent carrier of foreign seeds. Such goods frequently reach the retailer without repacking, and the hay or straw is thrown out upon the fields, or used as bedding for domestic animals and carried out with the manure

(7) Nursery stock. Plants are often accidentally introduced by means of seeds, bulbs and root stocks attached to nursery stock, or among the pellets of earth about the roots of nursery stock. The extraordinary development, of late years, of commerce in nursery stock has undoubtedly been responsible for the intra-continental carriage of many species of plants in this way.

Instances of the accidental spread of larger animals by man's agency are necessarily wanting. Of the smaller mammals the house rat and the house mouse have been accidentally carried in vessels to all parts of the world, and have escaped and established themselves, the former practically everywhere except in boreal regions, or only in its southern borders, and the latter even as far north as the Pribyloff Islands, as I am informed by Dr. Merriam. Small reptiles and batrachians are often accidentally carried by commerce from one country to another; but although there are probably instances of establishment of such species, none are known to me at the time of writing.

Land shells are often transported accidentally across the ocean in any one of the many ways in which the accidental transportation of plants and insects may be brought about, and by virtue of their remarkable power of lying dormant for many months are able to survive the longest journeys. The conditions which govern the establishment of species in this group, however, seem somewhat restricted, whence it follows that comparatively few forms have become widespread through man's agency, although Binney mentions a number of European species which have been brought by commerce into the United States and have established themselves there, mainly in the vicinity of the seaport towns of the Atlantic coast.

With the earthworms a striking situation exists. It has been shown that, "without a single exception, the Lumbricidæ from extra-European regions are identical with those of Europe; there is not a variety known which is characteristic of a foreign country." Careful consideration of the evidence seems to show that this is due to accidental transportation by the agency of man.

Comparatively little has been done in the study of the geographical distribution of insects.

The insects which are accidentally imported are carried in three main ways. Either (1) they are unnoticed or ignored passengers on or in their natural food, which is itself a subject of importation, such as nursery stock, plants, fresh or dried fruit, dried food-stuffs, cloths, lumber, or domestic animals; or (2) their food being the packing substances used to surround merchandise or the wood from which cases are made, they are thus brought over; or (3) they may be still more accidental passengers, having entered a vessel being loaded during the summer season, and hidden themselves away in some crevice. The coleopterists (Hamilton and Fauvel) make a distinction by name among these classes, calling the first group "insects of commerce," and the latter "accidental importations."

The practical point to which we must come, after summarising all that has been shown, is that since so many species have been imported by pure accident, and have succeeded perfectly in becoming acclimatised, may not much be accomplished by wisely-planned and carefully-guarded introductions? The work of Mr. Albert Koebele, first for the United States Government, afterwards for the State of California, and now for the Hawaiian Government, is certainly an indication, taken in connection with what we have shown, that thorough experimental work with predaceous and parasitic insects promises, in especial cases, results of possibly very great value.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The announcements of professors, readers, University teachers, and lecturers for Michaelmas term include the following:—A course of lectures on elementary pathology by the Regius Professor of Medicine, Dr. J. Burdon-Sanderson. A practical course of instruction in general pathology by the University lecturer, Dr. Ritchie. The Lichfield Lecturer in Clinical Surgery, Mr. W. L. Morgan, will lecture on elementary surgery. The Professor of Human Anatomy, Prof. A. Thomson, will lecture on human osteology. The Lecturer in Materia Medica, Mr. J. E. Marsh, will give at the University Museum a practical course of organic chemistry. The Savilian Professor of Geometry, Prof. W. Esson, will lecture at Merton College on (1) the theory of plane curves; (2) synthetic geometry. The Savilian Professor of Astronomy, Prof. H. H. Turner, will

lecture at the University Observatory on elementary mathematical astronomy. Mr. H. H. Champion will conclude his lectures on lunar theory. The Sedleian Professor of Natural Philosophy, Rev. Bartholomew Price, will lecture at Pembroke College on optics, physical and geometrical. The Waynflete Professor of Mineralogy, Prof. H. A. Miers, will lecture at the University Museum on elementary crystallography. The Waynflete Professor of Pure Mathematics, Prof. E. B. Elliott, on the theory of numbers. The Linacre Professor of Comparative Anatomy, Prof. E. Ray Lankester, on the Mollusca. Dr. W. B. Benham, on the flat worms; Mr. G. C. Bourne, on Von Baer's Law; and Mr. J. B. Thompson, on the morphology of the Ichthyopsida. The Professor of Experimental Philosophy, Prof. R. B. Clifton, on experimental physics. The Clarendon Laboratory will be open daily, from 11 a.m. to 4 p.m., for instruction in practical physics, under the superintendence of Prof. Clifton, Mr. Walker, Mr. Alsop, and Mr. Hudson. The Lecturer in Mechanics, Rev. F. J. Jervis-Smith, on elementary mechanics and the structure of simple machines. The Waynflete Professor of Chemistry, Prof. W. Odling, on elementary organic chemistry. The Aldrichian Demonstrator, Mr. W. W. Fisher, on inorganic chemistry; Mr. J. Watts, on organic chemistry; Mr. V. H. Veley, on physical chemistry; Mr. J. E. Marsh, on the history of chemical theory; Mr. J. A. Gardner, on aromatic compounds, other than benzene derivatives. The laboratory is open daily for instruction in practical chemistry from 10 a.m. to 4 p.m. The Waynflete Professor of Physiology, Prof. F. Gotch, will give (1) a general course of physiology; (2) advanced course on muscle. There will also be courses in histology, practical histology, and elementary physiological chemistry. The Professor of Geology, Prof. W. J. Sollas, will lecture on stratigraphical and physical geology. The Sherardian Professor of Botany, Prof. S. H. Vines, will give at the Botanic Garden (1) an elementary course (with practical work); (2) an advanced course (with practical work). The Professor of Anthropology, Prof. E. B. Tylor, will lecture at the University Museum on the anthropology of social, moral, and religious institutions.

Dr. J. R. Magrath, Provost of Queen's College, has been re-admitted as Vice-Chancellor for the ensuing year.

Mr. H. F. Pelham, Fellow of B.N.C., and Camden Professor of Ancient History, has been elected President of Trinity College in place of the Rev. Dr. Woods, resigned.

The following elections to Natural Science Scholarships and Exhibitions were made during the Long Vacation:—Merton College—to a Scholarship, Mr. F. W. Charlton, of Rugby School; to an Exhibition, Mr. E. L. Edlin, of Wyggeston Boys' School, Leicester. New College—to a Scholarship, Mr. E. H. J. Schuster, of the Charterhouse. Corpus Christi College —to a Scholarship, Mr. R. Stansfield, of Manchester Grammar School. Non-Collegiate Students—to a Shute Scholarship, Mr. C. H. Barber, of Wyggeston Boys' School, Leicester.

Mr. A. F. Walden (Magdalen College) has been appointed Lecturer in Natural Science at New College.

Mr. J. A. Gardner (Magdalen) has abandoned his work in Oxford for a post as Consulting Analytical Chemist in London.

Prof. W. J. Sollas delivered his inaugural lecture on Tuesday last. The lecture, which was of great interest, dealt principally with the part played by Oxford in the history of geology.

CAMBRIDGE.—The election of a Professor of Pathology, in the place of the late Prof. Roy, will take place on Saturday, November 6. The electors are Dr. Bradbury, Dr. Gaskell, Dr. Foster, Dr. Payne, Dr. Allbutt, Sir James Paget, Dr. D. MacAlister, and Dr. Latham.

Mr. J. Graham Kerr, of Christ's College, has been appointed Demonstrator of Animal Morphology in the place of Prof. E. W. Macbride, now of Montreal.

The University Lecturer in Geography announces two courses of lectures for this term. One on the geography of Europe will be suitable for history students; the other will be on physical geography.

THE late Sir J. C. Bucknill, F.R.S., has by his will left one-third of the residue of his estate, after paying certain legacies, to the president and treasurer of University College, London, for the purpose of founding a medical scholarship, to be called the Bucknill Scholarship, and to be awarded at least once in three years.

AT a meeting of the West Riding County Council, on Wednesday in last week, the Marquis of Ripon, in moving that a grant of 400*l.* be made to the Yorkshire College, stated that the debt on the institution, which a year ago amounted to 34,000*l.*, had been reduced to 28,000*l.*, and expressed a hope, not only that the whole of the remaining debt would soon be liquidated, but also that a permanent endowment would be secured. The motion was unanimously adopted.

DR. HANS REUSCH, director of the geological survey of Norway, has been appointed for the session 1897–98 to the Sturgis-Hooper professorship of geology in Harvard University, left vacant since the death of Prof. J. D. Whitney a year ago. Prof. Reusch will lecture on Vulcanism during the first half-year, treating volcanoes and eruptive rocks in general, earthquakes, and movements of the earth's crust. In the second half-year he will lecture on the geology of Northern Europe, and its relations to general geology.

A COURSE of twenty-five lectures on coal-tar distillation will be given, on Wednesday evenings, at the Goldsmiths' Institute, New Cross, by Mr. W. J. Pope, commencing on October 27. Special attention will be paid to methods of analyses, and to the plant used both in this country and abroad. The course will be fully illustrated with the aid of experiments and the optical lantern. Lectures of this kind, in which the subject is treated scientifically, do more to advance technical education than many courses of instruction in which manufacturing devices are described while the principles underlying them are left out of consideration.

THE following recent gifts to educational institutions in the United States are announced in *Science*:—Harvard College and the Massachusetts Institute of Technology will each receive about 750,000 dollars from the estate of the late Mr. Henry M. Pierce, under whose will they are, together with three other institutions, the residuary legatees.—The will of the late Eliza W. S. P. Field gives 80,000 dollars to the University of Pennsylvania, and makes the University residuary legatee of her estate.—Mrs. Esther B. Steele, of Elmira, N.Y., has given 5000 dollars towards the cost of a physical laboratory for Syracuse University. The building, which will cost about 25,000 dollars, will be erected shortly.—Furman University, at Greenville, S.C., has been given by Dr. and Mrs. F. A. Miles real estate valued at 20,000 dollars.—The will of the late Mr. Theodore Lyman bequeaths 10,000 dollars to Harvard University, and a collection of valuable books to the Museum of Comparative Zoology.—Ex-Governor Flower has given 5000 dollars to Cornell University for the purpose of a library for the Veterinary College.—By the will of the late Dr. Antoine Ruppaner the Harvard Medical School will receive 10,000 dollars, to be called the Dr. Ruppaner Fund.—Mr. H. H. Hunnewell has given 5000 dollars towards the endowment of the Surgical Laboratory of the Harvard Medical School.

THE Michigan College of Mines is the only technical school in the United States in which a full and elective system is adopted for its engineering instruction. The only subjects which are compulsory for all students are the principles of geology and the principles of mining; beyond these the student is allowed unrestricted freedom of choice in his studies, provided only that he shows that his preparatory knowledge is sufficient to enable him to take advantage of the instruction given. The following extract from the prospectus of the College for 1897–98 should be known to the managing committees of those of our technical schools and colleges which aim at filling students with heterogeneous knowledge, while leaving the intellectual and reasoning faculties undeveloped:—"If students are to achieve success here, it is imperative that they be able to collate facts, reduce them to order, draw sound conclusions from them, and use with facility the knowledge thus gained. All subjects of study, whether taught here or required for entrance, are regarded by the College as merely so many tools which the student, in proportion to the excellence of his training, can use to advantage in shaping his future. The necessity for a daily drill in reasoning out fully, and applying through varied methods, the fundamental principles of each subject of study cannot be too strongly impressed upon teachers; without it no educational results of sterling value can be obtained."

AT King's College, London, in conjunction with the Technical Education Board of the London County Council, advanced evening science classes are now being held on Civil Engineering, by Prof. Robinson, on Mondays, from 7 to 9; Mechanical Engineering, by Prof. Capper, on Tuesdays, from 7 to 9; Architecture, by Prof. Banister Fletcher, on Wednesdays, from

7 to 9; Natural Philosophy, under the direction of Prof. W. Grylls Adams, F.R.S., on Wednesdays, from 6 to 8.30; and on Pure Mathematics, by Prof. Hudson, on Thursdays, from 6 to 8. These courses are designed for students who have, by attendance at other classes, already reached an advanced stage in their technical work. Intending students should communicate by letter with the professors, taking the class they propose to attend, and giving particulars of their previous training. The courses of instruction afford an opportunity to students who can study only in the evenings to obtain instruction in well-equipped University laboratories, and make available to evening students the same advantages as are enjoyed by University day students, but they are only intended for those who are practically engaged during the day in some trade, business, or occupation. There are also held at King's College, the following free Saturday morning classes for teachers:—(1) Physics, on Saturday morning from 10 to 1, under the general superintendence of Prof. W. G. Adams, F.R.S. (2) Mathematics, by Prof. Hudson, on the teaching of elementary mathematics, on alternate Saturdays, at 10 a.m. (3) Strength of Materials (Saturdays, 10 a.m.), by Prof. Capper. (4) Principles of Practical Physiology (Saturdays, 11 a.m.), by Prof. Halliburton, F.R.S. The Saturday morning classes, we understand, are full, but there are still vacancies at some of the evening classes.

THE encouragement given to higher scientific instruction by the London Technical Education Board is shown in the latest number of the Board's *Gazette*, which contains a list of the principal public institutions of London at which instruction adapted to the requirements of the London University examinations above the matriculation will be given during the session just commencing. In the case of most of the institutions referred to in the list, evening as well as day classes are held in pure and mixed mathematics, experimental physics, chemistry, botany, zoology, biology, physiology, and geology. No institutions are included in the list except institutions of recognised university rank and polytechnics. Another list in the *Gazette* shows the principal evening classes in science, art and technology, to be held in London during the session 1897-98. The most noteworthy addition since last year to the supply of technical instruction is the scheme of instruction provided by the Northampton Institute in Clerkenwell. This institution has drawn up a very comprehensive series of courses especially adapted to the workers in the building and engineering trades and in artistic crafts, such as watchmakers, jewellers, goldsmiths, silversmiths and electrotypers. It is interesting to notice that this institution offers for the first time, together with the Regent Street Polytechnic, special instruction in cycle making. The electrochemical department is one that should be capable of considerable development in the future. The Northern Polytechnic also enters on its first full session. Admirable provision is made in this institution for the study of chemistry and physics, and the polytechnic is also provided with good carpentering and engineering workshops. The Borough Polytechnic is erecting new buildings for giving additional accommodation to classes in printing, bookbinding, boot and shoe making, carpentry, and wheelwrights' work. A model bakery is also in process of erection. The Battersea Polytechnic is providing additional accommodation for the teaching of chemistry and biology. The Bolt Court Guild and Technical School offers instruction in various branches in lithography and photo-process work. The classes at St. Thomas' Charterhouse School have been to some extent remodelled and placed on a new basis, and considerable additions have been made to the laboratory accommodation. The classes are being organised into a definite institution under the name of the St. Thomas' Charterhouse and Rogers' Institute.

SCIENTIFIC SERIALS.

Meteorologische Zeitschrift, September.—Investigations respecting wind velocity, by Prof. G. Hellmann. Our knowledge of wind direction over the globe is fairly satisfactory, but as regards the velocity it is defective, owing to the paucity of good anemometrical observations until within a few years. These observations are also affected by several causes, such as differences of height above ground, the exposure of the instrument, methods of reduction, and instrumental errors. The author has deduced the yearly period of wind velocity for all stations for which he could find a series of ten years' observations, for all parts of the world. The paper is accompanied by tables and diagrams, showing the mean velocity in metres per second for each month and for the year, and contains a valuable discussion of the results. The general conclusions are: (1) That the velocity increases with latitude, and decreases from the coast inland. (2) In the yearly period, the maximum in higher latitudes and exposed coasts occurs during the cold season, while in the interior of the continents it occurs between March and July. (3) The period of maximum velocity generally corresponds with that of the stormy season. (4) The minimum velocity generally occurs in August or September at those inland stations which have a spring maximum, while at coast stations which have a winter maximum, the minimum takes place in June or July. (5) The amplitude of the yearly period is greater on the coast than inland, but greatest in districts subject to strong periodical winds and monsoons.—Meteorology and terrestrial magnetism in Finland, by A. Heinrichs and E. Biese. The paper contains a summary of the meteorological observations made during the last 150 years, and which furnish good materials for investigations into secular changes of climate. The magnetic observations date from 1780. The organisation and discussion of these valuable observations during the last half of the last century and the first part of this, were principally due to the encouragement given by the University of Åbo.

The *Journal of Botany* for October reports a very remarkable addition to the British flora, in *Stachys alpina*, found by Dr. C. Bircknall in Gloucestershire, apparently wild. Mr. G. Murray gives an interesting account of his observations on the minute free-floating vegetation of the west coast of Scotland, carried on at the request of the Fishery Board of Scotland, with a description of the method used for the capture of the minute organisms.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 6.—The Rev. Canon Fowler, Vice-President, in the chair.—Mr. W. H. Bennett and Mr. B. Tomlin were elected Fellows of the Society.—Mr. Merrifield exhibited specimens of *Aporia cratægi* and *Argynnis paphia*, subjected to high and low temperatures during the pupal stage. In both species the examples which had been cooled were much darkened. Mr. Tutt showed for comparison the extremes of over 500 examples of *A. cratægi* bred or captured in Kent between 1860 and 1868, but none were so marked as those which had been artificially treated.—Mr. Tutt showed a remarkable melanic aberration of *Nemeophila plantaginis*, in which all trace of the pale ground colour of the hind wings was lost; also a series of *Abraxas ulmata* captured during the past summer by Mr. Dutton in the neighbourhood of York. Previously aberrations of the species had been rare, but a large number of this series were suffused with blue-grey or smoky-ochreous. Many of the aberrant forms were cripples. He also showed for Dr. Riding bred specimens of both broods of *Tephrosia bistortata* from Clevedon, Somerset, and bred specimens of *T. crepuscularia* and its ab. *delamerensis* from York. Hybrids were exhibited between *T. bistortata* (♂ and ♀) and *T. crepuscularia* (♀ and ♂), between the former and the form *delamerensis* (♀ and ♂), and between the two latter crosses. The offspring of the first crosses were roughly divisible into two groups following the parent forms, those of the second tended to become mongrel in appearance. Hybridisation led to the production of continuous broods, and certain broods tended to produce mlaes only. The colouration became more intense with increase in the duration of the pupal stage.—Dr. Dixey drew attention to the experiments on hybridisation recorded in Dr. Standfuss's "Handbuch der Paläarktischen Gross-Schmetterlingen," and gave a summary of the results.—Mr. Champion showed for the Rev. J. H. Hocking an example of the long-bodied moth *Satacoma agrionata*, from New Zealand; also one of *Protopaussus walkeri*, Waterh., from China, the subject of a later communication; and specimens of the rare *Emblethis verbasci*, F., from the Scilly Isles.—Mr. Jacoby showed a Halticid beetle with a singular abnormality, the side-margin of the prothorax being split to embrace a long process.—Dr. Chapman exhibited and described varieties of *Spilosoma lubricipeda* and *Acronycta psi* bred by Dr. Riding and himself. In the latter species the characters of the different races were

very stable.—Mr. Burr exhibited a Mantis, *Phyllocrania illudens*, from Madagascar, with a close resemblance to the dead leaves among which it lived, some of which were shown with it.—A new British coccid, *Kermes variegatus*, from Kent, was exhibited by Mr. Waterhouse.—Mr. G. C. Griffiths read a paper on "The Frenulum of the Lepidoptera," Mr. Kirkaldy communicated a "Preliminary Revision of the Notonectidæ, Part I.," and Mr. Waterhouse a "Description of a new Coleopterous Insect of the family Paussidæ."

PARIS.

Academy of Sciences, October 11.—M. A. Chatin in the chair.—New experiments on the liquefaction of fluorine, by MM. H. Moissan and J. Dewar (see p. 596).—The direct transformation of heat into electric energy, by M. Marcel Deprez.—An application of the remarkable magnetic properties of the nickel-steel alloys discovered by M. Guillaume. For these alloys a rise of temperature of about 50° causes the change from a strongly magnetic to a non-magnetic state.—On the spectra of the coloured components of double stars, by Sir William Huggins.—On the spectra of the principal stars of the trapezium of the Nebula of Orion, by Sir William Huggins.—Note relating to the saprophytic aptitude of the tubercle bacillus, to its relations with the bacilli of typhoid and *Coli communis*, and to the immunising and therapeutic properties which are possessed by the bacillus in its saprophytic state, by M. J. Ferran. By gradually modifying the culture medium, the tubercle bacillus was finally induced to multiply readily in ordinary meat broth at temperatures between 10° and 20° C. The bacillus during this time had undergone notable changes, so that morphologically it might be taken for the typhoid bacillus. Its pathogenic properties, however, remained unimpaired, but injections of the dead cultures proved to have an immunising effect upon guinea-pigs.—On orthogonal systems and cyclic systems, by M. C. Guichard.—On the geodesic lines of certain surfaces, by M. Émile Waelsch.—On a new algorithm, by M. Lémeray.—On a new mixed platinous salt, by M. M. Vèzes. By the action of oxalic acid upon potassium platinonitrite a crystalline platino-oxalonitrite is obtained, $K_2Pt(C_2O_4)(NO_2)_2 + H_2O$. This salt is very stable, and being but slightly soluble in cold water, it may be of service in the separation of platinum from its congeners. Above 240° it breaks up quantitatively into platinum, potassium nitrite, and carbon dioxide.—Method for the separation and distillation of bromine from a mixture of alkaline bromide and chloride, by MM. H. Baubigny and P. Rivals. The bromine is set free by the addition of sulphate of copper and potassium permanganate, and removed by a current of air at 100°.—Reversible transformation of styrolene into metastyrolene under the influence of heat, by M. Georges Lemoine. After a sufficiently prolonged heating, for a given temperature the final equilibrium is the same whether the starting point be styrolene or metastyrolene, provided that the volume be the same. The quantity of unaltered styrolene depends upon the volume open to the transformation.—On the temperature of maximum density of solutions of barium chloride, by M. L. C. de Coppet. The molecular lowering of the temperature of the point of maximum density is practically proportional to the weight of barium chloride dissolved in the litre of water.—On two colour reactions of pyruvic acid, by M. Louis Simon.—Action of nitric acid upon potassium cobalticyanide, by M. E. Fleurent. Indications of the existence of a nitrocobalticyanide analogous to the nitroprussiates.—Contribution to the biological history of phosphates, by M. L. Jolly. Prolonged maceration of muscular tissue in dilute nitric or acetic acids does not remove the phosphoric acid, the muscle still showing a strong reaction with the molybdic reagent.—On the reversal of the respiratory current in the Decapods, by M. Georges Bohn. The reversal of the current of water in the branchial chamber appears to be a general phenomenon in this group of Crustaceæ. The frequency of the reversal varies somewhat with the species, but is usually about two per minute.—On the systematic position of the genus *Ctenodrilus* (Clap.) and its relations with the Cirratulidæ, by MM. Félix Mesnil and Maurice Caullery.—On the segmentation of the egg of *Tethys fimbriata*, by M. Viguier.—On the evolution of the primary sieve-tubes, by M. G. Chauveaud.—Influence of the spring frost of 1897 upon the vegetation of the oak and beech, by M. Ed. Griffon. In the oak, the shoots destroyed by the frost were frequently replaced by new shoots. This was also sometimes the case with the beech, but more rarely. These new shoots showed a marked inferiority in the supporting and protecting tissues, certain fibres being completely wanting. The leaves also showed deviations from the normal.—On the invasions of black rot, by M. A. Prunet.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Applied Mechanics: Prof. J. Perry (Cassell).—An Elementary Course of Infinitesimal Calculus: Prof. H. Lamb (Cambridge University Press).—The Wealth and Progress of New South Wales, 1895-96, Vol. 1 (Sydney, Gullick).—The Facts of the Moral Life: Prof. W. Wundt, translated by Profs. Gulliver and Titchener (Sonnenschein).—Smithsonian Institution, Report of the U S. National Museum, 1893 and 1894 (Washington).—A Text-Book of Physics: Prof. E. H. Hall and J. Y. Bergen, new edition (New York, Holt).—Steam Boilers: G. Halliday (Arnold).—The Living Substance as such and as Organism: G. F. Andrews (Boston, Ginn).—Allgemeine Erdkunde: Hann Brückner and Kirchhoff, Fünfte Auflage, ii. Abtg. (Wien, Tempsky).—The New Man: E. B. Oberholtzer (Philadelphia, Levytype Company).—Laboratory Directions in General Biology: Dr. A. Randolph (New York, Holt).—Elements of Comparative Zoology: Prof. J. S. Kingsley (New York, Holt).—The Local Distribution of Electric Power in Workshops, &c.: E K. Scott (Biggs).

PAMPHLETS.—A Bibliography of Norfolk Glaciology: W. J. Harrison.—The Great Meteoric Shower of November: W. F. Denning (Taylor).—Humanitarian Essays (W. Reeves).

SERIALS.—Mind, October (Williams).—Journal of the Royal Statistical Society, September (Stanford).—Bulletin de l'Académie Royale des Sciences, 1897, No. 8 (Bruxelles).—Records of the Geological Survey of India, Vol. xxx Part 3 (Calcutta).—Annals of the Institute of Jamaica, September (Kingston, Jamaica).—Canadian Magazine, October (Toronto).—Indian Weather Review, Annual Summary, 1896 (Calcutta).—Engineering Magazine, October (222 Strand).—Zoologist, October (West).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1897, No. 1 (Moscou).—Himmel und Erde, October (Berlin).

CONTENTS.

THURSDAY, OCTOBER 28, 1897.

THE LOGIC OF DARWIN.

The Method of Darwin: a Study in Scientific Method. By Frank Cramer. (Chicago: A. C. McClurg and Co., 1896.)

THIS excellent and most useful little work arose, as its author states in the preface, "from the belief that the direct study of scientific method, as it is illustrated by the works of the accepted masters, is worthy of far more careful attention than is usually accorded to it." The method of Darwin was chosen for the author's purpose (pp. 23, 24) because of the importance of scientific method as a study, because "logicians and scientific philosophers draw their illustrations of scientific method almost exclusively from the physical sciences" which, although "fascinating on account of their brilliancy and their approach towards mathematical certainty," are less adapted than the biological sciences "to furnish models for the average student, because in the nature of their logical difficulties they approach more nearly to the experiences of common life," lastly because

"Darwin's custom of presenting all sides of a case very frequently led him to expose the original course of his thought and the order of his discoveries [rightly regarded by the author as a rare thing in a discoverer] so clearly as to make the reader almost feel that he and Darwin are making the discovery together. Darwin consciously recognised or unconsciously felt that there was considerable power to produce conviction in an understanding of the particular mode in which the truth was reached. He so habitually took the reader into his confidence that he will probably always remain the clearest model in the biological world for the study of applied logic."

Having made his choice for the weighty and cogent reasons which have been quoted above, the author proceeds to analyse Darwin's method, and the manner in which he applied it, continually illustrating his argument by reference to various discoveries and hypotheses—well selected and briefly but sufficiently described in language of great clearness and precision. The attitude of the writer towards his great subject is peculiarly pleasing. Although feeling the deepest respect for the "master-mind" of Darwin, and proclaiming "that Darwin's investigations, and the reasoning based upon them, have furnished the biological sciences with their dominant principles," the author frankly criticises and employs as illustrations any mistakes which he can find in the vast researches of the great thinker of our century, and having found them, attempts to explain the causes to which they were due.

The scope and object of the work may be inferred from the subjects of its chapters. The first deals with "Education and the Art of Reasoning"; the second, "Darwin's Views of Method"; the third, "The Starting Point of Investigations"; the fourth, "Exhaustiveness—Time given to Investigations . . ."; the succeeding four chapters are devoted to "Negative Evidence," "Classification," "Analogy," and "Induction" respectively; the succeeding five to "Deduction"; while the fourteenth contains "General Discussions"; the fifteenth, "Logical History of the Principle of Natural Selection"; the sixteenth, "Conclusion."

The whole volume is full of suggestive thoughts worthy of the deepest attention. The exigencies of space prevent more than a very brief selection to be made use of in this place. The distinction between the reasoning which follows the order of discovery, and that which follows the order of proof, is very clearly expressed, together with a plea, on behalf of the student, for the more frequent employment of the former. "Books and lectures are invariably built up on the plan of proof—the question how a conclusion was reached is rarely presented . . ." Hence

"the student is made a recipient. He is struck by the lucid arrangement of facts, the majestic sweep of the argument, and wonders why the world did not sooner get hold of the truth that seems so conclusive to him. In the laboratory the hand-books tell him what to look for and where to find it, and in the lecture-room the facts are arranged and the theoretical explanations are made for him. Thus in neither of the two practical divisions of the art of reasoning is he allowed to follow even the untrained impulses of his intellect" (pp. 19, 20).

Even when the importance of the reasoning employed in discovery is recognised, models of it will be found to be rare because a man of science,

"after establishing a conclusion to his own satisfaction, is not concerned with telling other people how he reached it, but with convincing them of its truth. For this purpose he throws his conclusions and facts into the order best suited to form a compact argument."

This statement seems to us to be not only true, but one of those truths which merely require to be pointed out in order to produce an important effect. This reasoning, stated in the author's clear language, is likely to lead observers to reconsider their methods of exposition, and determine occasionally to attempt the not uninteresting task of unravelling the tangled and devious lines by which they have been led to discovery.

The hard work, especially upon geological problems, performed in all the isolation and difficulties of the voyage of the *Beagle*, is regarded as the great educational influence of Darwin's life, and the author attaches importance to the fact that he was "unhampered by laboratory handbooks with directions for finding the facts, or by professors to do the reasoning for him, either before or after the facts were found" (p. 30).

The writer truly maintains that "the very grain of his scientific character was conscientiousness" (p. 31), a view which was eloquently put before the members of the Junior Scientific Club at Oxford by Prof. Michael Foster in one of the earliest lectures—I think the earliest—delivered before that Society.

One of the greatest of the many debts due to the author is the clear statement of the meanings of the terms induction, deduction, and the inductive method (pp. 35–39). Darwin, as we know, was not convinced by writers of a "deductive" cast; on the other hand, Darwin's friend and teacher Sedgwick accused him of forsaking the "inductive method." Deduction has come to be a term of reproach, induction a term of commendation, when applied to a scientific worker. Now the work before us puts all this in its true light, to the great help and comfort of

those who have not the time to make a special study of formal logic. Deduction, or "reasoning from the general to the particular, from a law, principle, or general fact to a particular fact," is as much a part of the scientific or so-called inductive method as induction itself, or "reasoning from particular to general, from facts to laws or principles." The scientific method

"includes all the logical processes, induction, deduction, analogy, verification—every way in which the intellect passes from fact to fact. This is widely different from what Bacon originally meant by inductive method; but practically no scientific man has ever followed Bacon's method. The inductive method, as illustrated by Darwin's own work, and as understood by all who think clearly on the subject, consists in the formation of an hypothesis from the facts by induction at the earliest possible moment in an investigation, deductive application of the hypothesis to known facts, and in the search for others that ought to exist if it is true, until it proves itself imperfect. By the help of the new facts the hypothesis is improved (by induction) and again applied, until by successive approximations it reaches the truth. So that in the so-called inductive or scientific method deduction is far more extensively used than induction."

In fact, as the author states, John Stuart Mill has "described the combination 'hypothesis, deduction, and verification' as the deductive method." Inasmuch as induction and deduction are both absolutely essential to the process above described, neither of them ought to be selected for the purpose of giving it a name; the process should always be called "the scientific method." When "induction" is used as a term of commendation, it is employed to mean the whole process, in which deduction, although not more necessary than induction, is "far more extensively used." When "deduction" is used as a term of reproach, it means "reasoning from postulates the truth of which is accepted *beyond dispute*"; it "starts from principles whose truth is not questioned," whereas

"in the scientific method the object is not merely to deduce consequences from laws or principles, but to establish the truth or falsity of those laws or principles themselves. Hence there is an incessant interplay of induction and deduction."

In considering "starting-points," it is well shown that Darwin's material lay all round him—the first facts already known, and sometimes the explanation hit upon, but the whole significance as yet unappreciated. This is shown to be the case with the local variation of the Galapagos fauna, the action of earth-worms, the reversion caused by the crossing of pigeons, and the facts upon which the investigation of insectivorous plants was begun. This is not only true, but most encouraging; such material is still thickly spread around every scientific worker, ready to lead to important researches, and yield the most valuable conclusions when its significance is understood. And the effect of practice and learning from example is well seen in the increasing power which this kind of understanding gains. The beginner who has not yet commenced his first research has much difficulty in finding a subject, and here it is that an inspiring teacher or friend may turn the whole current of his life by a few suggestive words. When he has had experience, the difficulty is to find time to undertake the innumerable researches which now seem to crowd around him.

In the chapter on "exhaustiveness" is shown the immense gain which we owe to the patience and thoroughness with which Darwin conducted his researches, even though

"he could have secured for himself the priceless gem of '*priority* of discovery' without the tedious years of work."

"One of the most notable legacies that he left to the ambitious student is his example of great energy and great patience; his incarnation of the truth that time, as well as reason, is the handmaid of science."

In giving a brief account of Weismann's theory of heredity (pp. 119–120), the erroneous impression might be gathered that the theory in question was framed in order to support natural selection and the contention that acquired characters are not transmitted. This is the wrong order; Weismann's study of the early history of the germ-cells, especially in Hydrozoa, suggested the theory, and this again opened up the question of the transmission of acquired characters and the scope of natural selection.

The "importance of theory" is well illustrated by the remarks upon Darwin's and Sedgwick's failure to see the traces of glacial action during their careful examination of the rocks at Cwm Idwal. "The secret of their failure is that they were not looking for it. It is usually the things that men look for that they see; and to look for things as yet unseen requires a theory as a head light" (p. 129).

Wallace's brilliant suggestion of the warning significance of the bright colours of caterpillars is described; but the great development which this and kindred subjects have undergone in recent years is undervalued by the writer who only sees "the enormous amount of wild deduction and half-digested observation." In a subject of wide general interest attracting an immense number of observers of all degrees of competence and experience, these strictures are likely enough to have force as regards a large number of the suggestions made; but, in spite of all errors of interpretation and observation, the whole subject has advanced immensely and greatly gained in extent and solidity since Bates' fruitful suggestion was brought before the Linnean Society in 1861, and Wallace's, before the Entomological Society in 1867. Some of the most important conclusions reached since then have not only been confirmed by an immense body of evidence brought together by their supporters, but have also been verified by the researches of those whose attitude was severely critical. The author's conclusion that "what is most needed is more light on the physiological causes at work within the animal, and producing and determining the distribution of colours," is, it is maintained, erroneous. Such researches, some of which have been and are being undertaken, are of the deepest interest and importance, but they are likely to shed but little light upon the significance of colour and pattern in the struggle for existence.

The very common mistake made by Darwin's critics in supposing that the inability to supply a cause of variation undermines the logical foundation of the theory of natural selection is well exposed (p. 166). In dealing

with "unverified deductions," the interesting case of the electrical organ of certain fish is considered in some detail, and the treatment should have been enriched by some account of Prof. Gotch's researches on the subject continued through so many years.

We regret to see the reference to Garner (on p. 191) in a work of such high merit; although the author wisely hesitates to accept any conclusions as yet made public.

We cannot do better than conclude this notice of Mr. Cramer's admirable and well-written little book, in his own well-chosen words:—

"Whatever may be the future of the particular conclusions which Charles Darwin reached, the general method which he employed and the general drift of his conclusions will have a permanent value. All his efforts tended towards the unification of knowledge. All his inductions became corollaries of one great theory; all his deductions had to do with efforts to test and prove the truth of that theory. The subordination of all the devices of the intellect to one great comprehensive purpose has given a unity of aim to all the great works of his life, and has made his general method conspicuously lucid, and has knit the products of his intellect into one great logical whole." E. B. P.

A THEORY OF PHYSICS.

Theory of Physics. By Joseph S. Ames, Ph.D. Pp. xviii + 513. (New York: Harper, 1897.)

MR. AMES has written a very interesting book, and one which to many students will be of great value. At the same time it is extremely condensed. To cover the whole range of physics, beginning with mechanics and properties of matter, including also sound, heat, light, electricity and magnetism in about 500 pages, is no easy task. Nor is it made less easy by the fact that Mr. Ames is not content with dealing only with the elementary parts of each subject, but carries his readers far into the region of modern theories. Thus Book ii., on heat, contains a chapter on the kinetic theory of matter; while the introduction to Book iv., electricity and magnetism, deals with the properties of the ether, and in the section on light we have chapters on double refraction and polarisation. The book is intended to be studied in an academic year of nine months by "students who have had no previous training in physics, or at the most only an elementary course." A large majority of these, we fear, will find beyond them the task of assimilating in so short a time all the nourishment it contains; the minority who succeed in the attempt will have a very good knowledge of physics, and all who read the book intelligently will benefit by its study.

There is a freshness about the style and about the manner in which the laws and facts of physics are presented, which is very invigorating, and which adds greatly to the interest of the book.

The book opens with a chapter on kinematics; this, on the whole, is clear and precise, but the proof given in § 18 of the formula connecting the space passed over by a body moving with uniform acceleration with its central velocity and the time of motion is incomplete.

The chapter on dynamics, dealing with motion and force, might usefully be amplified. The author starts from the law of the conservation of linear momentum for a series of bodies "entirely free from all external influences" as an experimental fact, which, so far as it has been tested, seems absolutely true and without exception.

Inertia is defined as a property of matter which becomes evident to our muscular senses when we try to change the motion of matter, and two bodies are said to have the same mass when they have the same inertia; the masses of two bodies are supposed to be compared by observing the velocities which a given spiral spring can confer on them when compressed to a definite extent and allowed to act on each in turn.

Knowing the masses, the momenta of a series of bodies having motions of translation only can be calculated, and the law of the conservation of momentum tested.

The rate of change of the linear momentum of a body with respect to the time is then defined as the "force acting on it," and Newton's laws of motion are explained. Such an explanation of dynamics has many claims to our attention, and is certainly more logical than that adopted in many modern books; at the same time, it is more difficult for the ordinary student to grasp; he knows force as muscular exertion. The schoolboy who illustrated his reply to his teacher's question, What is force? by doubling his fist and striking his classmate is typical, and the difficulties of introducing him in his first study of dynamics, to "force" as a name for rate of change of momentum are considerable. The book is, the author implies, intended for students working in a class, seeing demonstrations and doing experiments for themselves; thus opportunities for explanation and amplification will naturally arise; still we wish the author had found space to develop this part of his book more fully.

Matter in rotation is dealt with in § 41, and the elements of rigid dynamics are based on the law of the conservation of angular momentum. This law is stated as independent of the law of the conservation of linear momentum; it is usually deduced from the latter. The treatment of the section on liquids introduces fewer novelties than that dealing with solids; the important idea of pressure at a point, however, deserves, we think, a fuller explanation than is accorded to it; the sections on capillarity are clear, and the principal phenomena of osmosis are described. The parts of the book on sound and heat do not call for any very detailed notice; the main criticism, to which the book is open throughout, applies here also: advanced portions of the subject are somewhat frequently referred to in so brief a manner that the student cannot, without further assistance, obtain really clear ideas on the subjects dealt with.

Book iv., electricity and magnetism, commences with a reference to the ether, with which, we are told, electric and magnetic effects are intimately connected. But the earlier sections of the book describe the production of electric charges and the ordinary phenomena of electrostatics in the usual manner. It is stated, § 215, that the property of attraction possessed by an electrified body "will be shown in Article 221 to be due to changes in the strain of the medium round the charged body"; but the demonstration given in § 221 can hardly be called a proof.

The difficult questions involved in the theory of primary

cells are treated of in § 242, but not, we think, quite successfully. It is stated, among other things, "that there is a *slight* difference [of potential] at the junction of the copper and the zinc," and it is implied that the charge in potential in passing from the liquid to the zinc is considerable. "These facts, it is said, may be proved by direct experiment." While in all probability these statements would be found true if we could measure the actual potential of the zinc, the copper and the acid, direct experiments, measuring as they do the potential in the air near the zinc and copper, seem to show us that these differ in potential considerably.

Book v. deals with light, and bases the explanations entirely on the wave theory.

There is much to be said for such a treatment; still some of the proofs given necessarily want in rigidity—*e.g.* that in § 306, on the law of reflection—and the clearness of conception acquired by the student who makes a careful study by graphical methods of the phenomena afforded by lenses and mirrors is a great gain to him.

The book is clearly printed and admirably got up; the diagrams are good; the plate of spectra in black and white, facing p. 264, is a marked improvement on many of the chromolithographed plates we have seen.

OUR BOOK SHELF.

A Detailed Course of Qualitative Chemical Analysis of Inorganic Substances, with Explanatory Notes. By Arthur A. Noyes, Ph.D. Pp. 89. Third edition. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THE present work arose out of the difficulty experienced by the author in attempting to give a thorough course of qualitative analysis in limited time to large classes of students. Of course in a work dealing with so hackneyed a subject anything new must be looked for in the arrangement of the material. It is a common practice to preface the actual analytical separations by a course of test-tube reactions with each metal and acid, with the object of combining a course of systematic inorganic chemistry with the study of analysis. The author prefers to keep the two separate, thinking that the former is better taught by a course of inorganic preparations than by the test-tube reactions, which mostly involve mere questions of solubility. The present course accordingly plunges at once into the separations of the metals, passing on to the wet tests for acids, and concluding with dry tests and an excellent chapter on the preliminary preparation of substances for analysis. The book is intended to be used in the laboratory, and to be accompanied by lectures on, and demonstrations of, the analytical processes. When employed in this way it is thoroughly to be commended. Minute directions are given for carrying out each operation, followed by notes explaining the reason of everything which is done, and the apparently anomalous results which may arise from the neglect of the precautions specified, or from other causes. These notes form a peculiarly excellent feature of the book, and reveal the hand of the experienced teacher. The section on the tests for acids is, perhaps, the least satisfactory, the tests selected being, in the writer's opinion, not invariably the best available.

The printing, paper, and binding are uncommonly good, and a useful index is provided.

Physikalische Chemie für Anfänger. By Dr. C. M. van Deventer; with a preface by Prof. J. H. van 't Hoff. Pp. 167. (Amsterdam: S. L. van Looy. Leipzig: W. Engelmann, 1897.)

PROF. VAN 'T HOFF says, in his preface, that he had experienced, in his lectures to medical students, the want of a text-book dealing with the general laws of chemistry in an elementary way, a want which was supplied by Dr. van Deventer's book. The book begins with definitions of terms, and then goes on to the laws of chemical combination, the laws regulating the behaviour of gases, Avogadro's hypothesis, atomic and molecular weights. The fourth chapter deals with the specific heats of elements and compounds, and contains an excellent *résumé* of the more important results of thermo-chemistry, concluding with the laws of mass action and some pages on distillation. The last three chapters deal briefly with the theory of solutions, spectroscopy and photo-chemical action, and the periodic law. Although it might be objected that the discussion of the asymmetric carbon atom on p. 40 is somewhat beyond first-year students, that too much space is devoted to the erroneous principle of maximum work, and too little to the hypothesis of electrolytic dissociation, which is of such great interest in connection with the qualitative analytical work which forms a considerable portion of the laboratory practice of elementary students, yet these are matters on which different teachers would entertain different opinions, and on the whole it must be said that the work is thoroughly well done and suited to the purpose for which it is intended.

Bromide Enlargements, and How to Make them. The Popular Photographic Series, No. 13. By J. Pike. Pp. 64. (London: Percy Lund, Humphries, and Co., 1897.)

THERE are many of us who delight in the use of hand cameras, but who find those of larger size too cumbersome and unwieldy to carry about. With the former pictures may be obtained without those numerous preliminaries which must be gone through every time a picture is required, such as putting up the tripod, setting up the camera, &c., but their size necessitates that the pictures must be rather small. These latter can, however, be enlarged when required, and it is with this special subject that the present little book deals. The process is quite simple, as will be gathered from the sixty-four pages in which the author brings together all information that the operator can require. Not only is the actual method of making bromide enlargements described, but useful hints will be found on constructing one's own apparatus, the different sources of light available, screens, skies and sky printing, &c. The book forms an interesting addition to the popular photographic series, and it should be widely read.

The Machinery of the Universe: Mechanical Conceptions of Physical Phenomena. By Prof. A. E. Dolbear, A.B., Ph.D. Pp. vi+122. (London: Society for Promoting Christian Knowledge, 1897.)

IN December 1895, Prof. Dolbear delivered before the Franklin Institute of Philadelphia a lecture on mechanical conceptions of electrical phenomena, and the substance of it was published in NATURE a year ago (vol. lv. p. 65). The lecture has been enlarged by the addition of a section in which the properties of matter and the ether are compared, and it now forms one of the "Romance of Science" series of the Society for Promoting Christian Knowledge. The aim of Prof. Dolbear is to show that the mechanical antecedents of physical phenomena are sufficient to explain the phenomena without assuming the existence of other factors.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On the Meaning of Symbols in Applied Algebra.

REFERRING as briefly as possible to Prof. McAulay's letter on page 588, I contend (1) that no complex reasoning is necessary to show that the commutative and associative laws hold for the symbols of units or (better term) standards; a simple method was indicated in vol. xxxviii. p. 281; and (2) that meaningless things like the square root of a foot do not appear in any correct final result. It is true that the square of an hour is meaningless too, but the *apparent* occurrence of such a thing, in acceleration for instance, is otherwise explicable; for velocity is a real and simple physical quantity.

Magnetic intensity is not really the time rate of the square root of a linear density, as Prof. McAulay imagines that physicists suppose it to be; he has omitted an essential factor; and when we discover the real nature of μ, we shall find it such as to satisfactorily rationalise the gibberish he properly "abhors." If, for instance, μ turns out to be an etherial density, the specification of H would be length divided by time.

University College, Liverpool, OLIVER J. LODGE.

October 22.

Strange Instinct of Fear in the Orang.

THE following circumstance which occurred at the Zoo on Sunday last, and was witnessed by Mr. W. E. de Winton and myself, is perhaps worth putting on record.

We were watching and making friends with the baby orang, and my wife was standing by, holding on her hand a muff manufactured out of the skin of the Indian flying-squirrel, with the unstuffed skin of the head to the front, and the bushy tail hanging loosely over it. Suddenly, but quite gently, she stretched out the muff towards the orang, but at the sight of the advancing fur a light of unmistakable terror sprang into the creature's eyes. Upon repeating the experiment, the ape promptly rolled over backwards as the quickest way of removing himself from the immediate vicinity of the terrifying object; then gathering himself together, climbed up the branches of his tree, and retreated to the back of the cage, keeping all the while a wary and frightened eye upon the muff, as if in fear of an attack from behind. It is interesting that the whole performance was carried through without the utterance of a sound on the part of the orang; but that he was acting under the influence of fear, there is, I am persuaded, no doubt. His behaviour, in fact, reminded me irresistibly of the behaviour of a friend's little child of ten months old, who evinced similar signs of fright upon being shown a toy fur monkey for the first time. R. I. POCOCK.

Natural History Museum, October 25.

Hereditary Colour in Horses.

MR. FRANCIS GALTON'S very characteristic article in the current number of NATURE, page 598, upon hereditary colour in horses, appealed to me with more than usual interest, as for some months I have been planning a somewhat extensive investigation into the hereditary transmission of various characteristics amongst the higher members of the animal kingdom, including that of colour in horses.

It may be of interest to your readers if I summarise a recent quite preliminary investigation upon the same matter, which I shall hope at some future time to work out more thoroughly. I may add that, contrary to what Mr. Galton experienced with the data he used, all the grey foals in my data did *not* come from grey dams.

An examination of the offspring, numbering in all 1566, of one special class of mares shows that there were 686 offspring which resembled the general colour of the dam, and 880 which differed; or a preponderance of 28 per cent. dissimilar. Of these:—

313 colts were the same in general colour as the dam.
394 ,, ,, *not* ,, ,, ,, ,,
373 fillies ,, the same ,, ,, ,, ,,
486 ,, ,, *not* ,, ,, ,, ,,

Hence we have two broad results: (1) the excessive preponderance of fillies over colts; and (2) that the colts more frequently resemble the colour of the dam than do the fillies. For every hundred fillies there would be 102 colts resembling the dam.

Truly this is not a large difference, but, based as it is upon over 1500 cases accurately described and exactly tabulated, it seems worth calling attention to, as it carries Mr. Galton's analysis a step further, and points to the possibility of a further development in an exceedingly interesting branch of heredity.

Churchfield, Edgbaston. F. HOWARD COLLINS.

Dog Running on Two Legs.

IT is not necessary that a dog should be compelled by accident to resort to this mode of progression (p. 588). Some years ago I had a clever little Scotch terrier which would occasionally run in this way. It would balance itself on two legs, sometimes on one side and sometimes on the other, holding the other pair up, and run with perfect ease for a considerable distance. As this is the only instance I ever met with, or heard of, I do not suppose that the accomplishment is a common one with dogs.

Highfield, Gainsborough. F. M. BURTON.

THE OBSERVATION OF METEORS, WITH ESPECIAL REFERENCE TO THE LEONIDS.

DURING the next few years a large amount of attention will be given to meteoric astronomy in general and to the great shower of Leonids in particular. The present may, therefore, be an appropriate time to refer to a few points connected with this interesting branch. It has often occurred to the writer that it would greatly facilitate the comparison of different materials if observers adopted one uniform method of recording meteor-flights. Some merely give estimated compass bearings, and a rough guess at the altitude and inclination of path, others give the place and direction according to conspicuous stars near, others simply mark the courses on a map without reading off the individual positions, while others give the R.A. and Decl. of both beginning and ending of every object observed. It would be a great advantage if every one tabulated results according to the latter method. It can easily be done if the tracks, as observed, are pencilled upon a celestial globe or star chart, and the positions read off; and this is a much more exact method than describing the flights by stars near which they happen to pass.

Another point is that the accurate observation of meteors demands a considerable amount of practice. It would, therefore, be a most useful preparation for intending observers of the Leonids if they carefully watched the Perseids of August, Orionids of October, and some other prominent displays, and gained a little practical experience of the work. They would find it of material assistance to them, and would enable the Leonids to be observed more expeditiously and correctly than must otherwise be the case. Accounts are sometimes published of meteoric showers by persons who are reporting a perfectly novel experience, and it is not too much to say that such descriptions are useless as regards many essential details. A perfect novice may of course stand and count the number of meteors visible, and may be capable of describing a star-shower in a general way, but he is heavily handicapped when it comes to recording the more difficult features with precision.

What photography may achieve in meteoric work we cannot definitely foresee, but it is quite certain that the proper observation of meteors, as at present conducted, demands the work of a lifetime. A man must watch for meteors all night, and suitably record them, and by day he must analyse the observations and determine the radiant points. The observer need not, perhaps, absolutely isolate himself from all other work; but the meteoric

branch is such an extremely difficult one, embracing, as it does, some thousands of streams which exhibit many different peculiarities, that in order to grapple with the subject successfully he must make it his constant care and the object of his earnest efforts and thoughts during many years.

Fortunately the Leonids are to be classed amongst that description of meteors comparatively easy to observe and record. They leave streaks for a second or two, and from these the directions are to be determined with great facility and precision. It is also a fortunate circumstance that the radiant point is surrounded by the well-known stars in the Sickle of Leo. The lines of flight may therefore be readily carried back in the correct directions by projecting a straight wand upon the streaks, and noting their points of convergence relatively to the stars named.

The writer has usually found the radiant very definitely and sharply defined, and it can be readily fixed to within 2° of probable error. But naked-eye observation is capable of much more accurate results than this, if, during a pretty active return of the shower, the observer will independently fix the radiant during, say, successive half-hours of the night; he will in this way get eight, ten, or twelve positions, from which he may derive the mean place of the radiant to within about $\frac{1}{4}$° of error.

The Leonid radiant is sometimes described as very diffuse; but this is a false effect brought about by two circumstances which, if properly allowed for, would leave a very definite and satisfactory position. One cause of its apparent diffusion is that meteors are attributed to it which really belong to the minor showers in Leo and the surrounding region, of which quite a large number exist. They display similar visible characteristics to the Leonids, and can only be dissociated from them by the exercise of extreme care in noting their directions of flight. In *Popular Astronomy*, vol. i. p. 298, I gave a list of sixty-eight meteoric radiants situated in various parts of the heavens, and active during the period November 10–15; and in *The Observatory*, vol. xx. p. 306, a table of seventy-two circum-Leonid showers was published. Those which chiefly affect the determination of the Leonid radiant are placed near δ and ι Cancri, μ and ξ Ursæ Majoris, λ Hydræ and π, λ, τ and β Leonis. The meteors are swift, and usually leave streaks. Another contributing feature to dispersed radiation is found in the unavoidable errors of observation. Great care and habitual practice can, however, reduce these to small limits, and it will be found that the radiants derived from accurate materials will be pretty sharply defined.

The probable error in the case of different observers must, however, vary to a considerable degree, for practice cannot equally eliminate inaccuracy from amongst them all. In catching and retaining correct impressions of meteor flights, natural aptitude exercises an important influence. It is like a game of skill depending upon the eye, judgment and quickness in execution. Really few will excel, while many will only attain mediocrity, and some must altogether fail to acquire the desirable proficiency, even after years of experience.

The horary rate of appearance of Leonids cannot be exactly determined unless the contemporary showers are considered, and their meteors separated from the true Leonids. Many observers count every meteor proceeding from the general direction of Leo as necessarily a Leonid, and thus the horary number is exaggerated. If an inexperienced observer gives 20 as the number of Leonids seen in an hour, the fair inference is that not more than 14 or 15 of them were true members of that system. During very strong returns of the shower this point may, however, be disregarded, for the minor streams can then exercise very little relative influence on the results, and are virtually obliterated by the superabundance of Leonids.

One new feature to be attempted during the ensuing return of the Leonids is to photograph the meteor group of November 1866 in space, and an excellent ephemeris of its nearly stationary position in Libra and south-eastern limits of Virgo, during the first four months of 1897, was given in *Monthly Notices*, lvii. p. 70–2. Some people will regard the idea as little more feasible than opening a correspondence with the inhabitants of Mars, and certainly there appears very slender prospect of its successful realisation. The experiment ought, however, to be tried. Let us support every project which has a possible side to it, for it is quite clear that many things deemed beyond our reach are capable of attainment by persevering efforts and proper means. Novel attempts of this kind, if seemingly chimerical, should not be hastily condemned or necessarily considered as vain labour. Mr. Roberts's photographic search for a trans-Neptunian planet was a novelty, and it proved vain labour; but who will say that it ought not to have been undertaken? The same may be said of Mr. Barnard's similar search for a satellite to the moon. To look for a fifth satellite of Jupiter was decidedly a novelty in these modern times, and yet it proved productive. Let, then, new researches like these have our encouragement; for if they do not always succeed, they stimulate our interest and enthusiasm, and make the science more attractive by imparting to it a welcome freshness and, perhaps, a touch of romance.

As to the practical aspect of the question, it is fair to conclude that the Leonid group of 1866 is too faint an object to be ever impressed on a photographic plate, especially when its distance is so great as during the past spring, for on March 1 this was equivalent to 800,000,000 miles, and not far short of the mean distance of Saturn! In the great meteor storm of November 27, 1885, when the meteors were more thickly congregated than in the Leonid shower of November 13, 1866, Prof. Newton computed that "the space in the meteroid group corresponding to each single visible meteor was in the densest portion of the group, a cube whose edge is 32·8 kilometres or 20·4 miles." This means one small pebble in twenty miles of space! The degree of illuminating power exhibited by a group of these bodies, separated by such distances, must be infinitesimally small. If any one were to attempt to photograph Tempel's comet (1866 I.), on its return journey, the chances of success would be far greater, for though the comet has still to run eighteen months before reaching perihelion, it is nearer to us than the meteor group of 1866, and must be infinitely brighter, as it doubtless represents the richest part of the stream. We must remember that Tempel's comet passed its perihelion on January 11, 1866, while the meteor-group reached it ten months afterwards; and it is quite fair to suppose that the meteoric train of the comet, at a distance of some hundreds of millions of miles from the nucleus, must be relatively tenuous as compared with that part in the immediate wake of the comet. The meteors may not, however, show a regular decrease in numbers according to distance from their derivative comet, but may probably consist of a series of groups. There is every reason to believe that disruptions of a violent character affect the physical character of comets, and this was well exemplified in Brooks's comet (1889 V.), visible, in 1896, at its second observed return, which was seen separated into five portions on August 1, 1889. There is, however, every probability that the meteor cluster of 1866 is some hundreds of times fainter than Tempel's comet; yet even the latter was not visible to the naked eye in December 1865, or January 1866, and indeed the object was only followed for a month in telescopes. It might be a good plan to endeavour to photograph the comet first, and then fish for its associated meteor-stream; for the easier objects are sometimes capable of leading us up to the discovery of the more difficult ones.

W. F. DENNING.

THE KLONDIKE PLACERS.

WHEN the attention of the world was called to the new Canadian gold-fields during the past summer, few people had ever heard of the Yukon placers. Nevertheless, prospecting has been carried on for over fifteen years throughout the whole length of the river, both in the North-western Territory of Canada, and across the border in Alaska. The number of gold diggers at work tended to increase from year to year, but the severity of the climate, and the difficulty of getting supplies into the country checked its progress, especially before 1892, when the first steamers were placed on the river by a trading company. In 1896 the total production of gold amounted to little more than 100,000*l*. with about 2000 miners at work, and although some of this was produced on the Canadian side of the boundary, little attention was paid to it by the Geological Survey of the Dominion, and it was reported as if it were a part of the Alaska output.

On September 6, 1896, however, Mr. W. Ogilvie, the surveyor of the Yukon district, reported to the Canadian Government that rich discoveries of gold had been made on Bonanza Creek, a tributary of the Klondike, which flows into the Yukon some fifty miles south-east of Fort Cudahy, where he was stationed, and about the same distance from the U.S. boundary. Mr. Ogilvie continued to make reports during the winter, and from his book on the subject, lately published by the Dominion Government, most of the following information is obtained. The discovery was made by G. W. Cormack, who had been in the country since 1887, and a rush from Cudahy at once took place, 200 claims extending 20 miles along the creek being staked out within a fortnight of the time when the strike became known. Later on, when the neighbouring creeks El Dorado, Hunker, Dry Fork and West Fork were found to promise well, the other diggings on the Yukon were almost entirely deserted. Miners travelled with sleds over the snow from Circle City and other places still further off in United States territory, and by January 1897, 2000 men were encamped on and around the Klondike, with scanty supplies and little protection against the cold, although a temperature of 50° below zero Fahrenheit was not unusual. Many men bought a share in the claims even as early as this for thousands of dollars, and the few labourers who preferred to work for hire received one and a half dollars per hour, working as long as they liked.

Little gold was actually recovered in the winter, the "pay dirt" being dug out and piled up to wait until the spring, when the frost had gone and water was plentiful. Some extraordinary yields were announced, however, as the result of prospecting washings, 250 dollars in a pan (containing about a quarter of a cubic foot of gravel) being reported, but not generally believed. There is little doubt, however, that from one to ten dollars per pan was usually recovered in El Dorado and Bonanza creeks, although the diggers, as is their wont, were very reticent.

In spite of this reticence and the lack of communication with the outside world, news of important discoveries leaked out, and in the early spring the rush into the Yukon basin from British Columbia and California was unprecedented. By May over 2000 people had entered the country by one route or another, and were pushing on to the Klondike, where the town lots of Dawson City had been staked out, and building was in progress. At the beginning of July the population of Dawson City had risen to 5000, and more people kept coming in; but the supplies brought by them were far from being adequate, so that the scarcity of provisions continued almost unabated, and as the summer wore on became more and more pronounced, until it was evident that the 7000 people who will be shut up there in the ensuing winter must suffer serious privations, if not absolute starvation, before the Yukon River becomes navigable again next spring.

Meanwhile, about July 15, the first miners from Klondike reached San Francisco, bringing with them about 400,000*l*. in gold, and the excitement, which had been growing on the Pacific sea-board, became intense, and spread over the whole of the United States and Canada, and even reached England. Thousands of people started for the Yukon without sufficient supplies, and regardless of the fact that it was already too late in the season. Fortunately the means of transport failed. The steamers on the Yukon were delayed, owing to the lowness of the water in the river; and the difficulty of transporting large quantities of stores over the passes leading from the sea-board to the interior prevented the southern route from being used by the majority of the immigrants, so that not one in ten of those who started late in the summer succeeded in reaching the Klondike, and starvation, if it comes, will not be largely due to the newspaper boom of July and August.

Turning from the history of the district to the description of the gold-fields themselves, it may be remarked at once that the placers, which have caused so much excitement, do not present any very unusual features. The gravels are in general about 20 feet thick, and, as usual, the parts immediately overlying the bed-rock are the richest. The pay dirt is, however, said to be frequently 5 or 6 feet thick, and about 30 feet wide, the whole width of the creek-beds varying from 100 feet to 600 feet or more. The gold is very coarse, and is therefore easy to save with crude washing appliances. It is of lower standard than most placer gold, containing only about 800 per 1000 of gold, whilst the average fineness of Californian gold is about 880, and of Australian about 950. No very large nuggets have been found yet, the largest recorded being worth about 2*l*. 10*s*., and in this particular the placers resemble those of the Pacific coast generally, where large nuggets are very scarce.

Mr. Ogilvie considers that the auriferous gravels have been derived from the crystalline rocks lying to the south of the Klondike, between it and the Stewart River, which also contains gold, but no evidence has been brought forward as to their age. An interesting point in connection with the question of age is that the ground remains perennially frozen, only the surface being thawed in summer to the depth of two or three feet. It would appear therefore that, like the placers of Siberia, these deposits have remained undisturbed and unaltered ever since the Glacial period, and perhaps some such evidence of this will in course of time be discovered, as was afforded by the remains of mammoths and other animals in the Siberian frozen mud.

It is worthy of note that the comparative lowness of standard of the gold is, under the existing conditions, in favour of the view that the placer gold is derived from the erosion of auriferous quartz lodes formerly existing at a higher level, and has not been formed *in situ* by being deposited from solution. For, according to those who support the former view, placer gold becomes of higher standard than reef gold after it has found its way into the drifts, the base metals being gradually removed by the solvent action of running water, in which gold is not readily soluble. Since, however, the Klondike gold has been frozen up during a large part of the time since it was deposited in the gravel, it is obvious that it cannot have altered in composition so much as the gold in river sands further south, and might be expected to resemble the gold in the parent lodes, which is not usually more than 800 fine. The low standard of the gold is not so readily accounted for by the accretion theory of formation of placer gold. Some auriferous veins have already been discovered both in the creek valleys and on the mountains round them, although no direct evidence has yet been adduced to connect these

lodes with the sources of the placer gold. Moreover, many nuggets have been found adhering to quartz, so that the weight of evidence appears to be in favour of the view that the gold in these placers, at any rate, has been laid down there by mechanical rather than chemical processes.

The method of working the placers resembles that followed in the frozen placers in the Trans-Baikal in Eastern Siberia. Prospecting is done chiefly in the short summer when the snows are gone and water is plentiful, but the excavation of the gravel is best carried on in winter when nothing else can be done. The shafts are sunk to the pay dirt, and tunnels are then run through the gravel, following the rich material wherever it may be. To soften the ground a pile of wood is placed against the end of the drift and set on fire, the gravel, to the depth of about a foot, being brought down by pick and shovel after the fire has gone out. As M. Levat points out in speaking of the Siberian placers (*Eng. and Mng. Jour.*, June 12, 1897), the method is not an ideal one, but the circumstances are difficult. The frozen soil cannot be easily worked with the pick, as it does not break but simply mats together under a blow. For the same reason powder and dynamite have little effect; moreover, the drilling of the alluvium through which quartz boulders are scattered is a slow and costly work. The gravel is piled up to await the arrival of spring, when it is washed in the cradle or in short sluices, which are expensive owing to the high cost of timber.

The future of the country can hardly be foreseen as yet. It is certain that next year hundreds of miles of unworked creek beds will be vigorously prospected by the thousands who will enter and find that all the ground on the tributaries of the Klondike is already occupied. If, as seems likely, other fairly rich placers are found, many of the men will remain in the country, and with the development of the auriferous quartz lodes and the beds of lignite, some of which have already been discovered, the Yukon district of Canada will probably become one of the steady producers of gold like California or Colorado. The output this year will probably not greatly exceed 800,000*l.*, partly owing to the scarcity of water in the creeks this summer, which has interfered with the washing in the creeks. Nevertheless, the Canadian production of gold for 1897 will with this addition be raised to over 1,000,000*l.*, or considerably above that of 1863, which amounted to 860,000*l.*, and is still the highest on record. There is little doubt that this will be largely augmented in the next few years, and that the Yukon district will be the richest Canadian gold-field yet discovered.

T. K. ROSE.

NOTES.

THE International Congress of Zoology is to meet in Cambridge on August 23, 1898, and a general committee has been formed to make arrangements for its reception. The President-elect (Sir William Flower) has summoned a meeting of the committee, to be held at the rooms of the Zoological Society, 3 Hanover Square, W., at 2.30 p.m. on Thursday, November 4; and special notices have been addressed to those who have expressed their willingness to act as members of the committee. Zoologists who have not been asked to join the committee are requested to communicate with the Local Secretaries (International Congress of Zoology), The Museums, Cambridge.

H.M. THE KING OF BELGIUM has conferred upon Prof. D. E. Hughes, F.R.S., the decoration of Officier de l'Ordre Leopold. This mark of appreciation is due to Prof. Hughes' work in connection with his printing telegraph instrument, which the Belgian Government have largely used during the last twenty-seven years. The Belgian Minister of Railways, Posts and Telegraphs has telegraphed to Prof. Hughes the congratulations of the telegraphic service upon the distinction conferred upon him.

AT a meeting of the Royal College of Physicians of London last week, the Moxon medal was awarded to the President, Sir Samuel Wilks, Bart.; and the Weber-Parkes prize of 150 guineas and a silver medal to Dr. Arthur Ransome for the best essay on consumption and its treatment. A similar medal, called the second medal, was awarded to Dr. Peter Paterson, of Glasgow. The Baly medal was awarded to Prof. Schäfer, of University College. This medal is given every third year to the person who has distinguished himself the most in physiology during that interval.

THE Reale Accademia dei Lincei has recently elected the following associates and correspondents:—National associate, in the section of zoology and morphology, Prof. G. B. Grassi; correspondent, in the same section, Prof. G. Fano; foreign associates in mathematics, Profs. H. Weber and T. Reye; in mechanics, Prof. G. H. Darwin; in mathematical and physical geography, Prof. F. R. Helmert; in geology and palæontology, Prof. A. Gaudry; in physiology, Profs. H. Kronecker and O. Schmiedeberg.

WE print in another part of this number an abridgment of a report drawn up by a deputation appointed by the Manchester Technical Instruction Committee to visit technical schools, institutions, and museums in Germany and Austria last July and August. This is the second time Manchester has delegated some of its educational advisers to see what foreign countries have done and are doing to establish an efficient system of scientific and technical education. The recent visit showed the deputation that since 1891 there has been a considerable development throughout Germany of educational means and resources. The technical education movement in England during the past five or six years has not gone unnoticed in Germany, and the effect has been the extension and improvement of facilities for imparting instruction of a scientific and technical character, the evident determination of Germany being to maintain the lead in higher scientific education. It is satisfactory to know that the educational authorities of some of our cities are also alive to the importance of scientific instruction as an aid to the development of our commerce and industries. When a deputation from an industrial city like Manchester speaks of continental schools and methods in the glowing terms of the report abridged this week, and urges the extension of higher scientific instruction as the force which will enable us to keep our place among the nations, it is time to give thanks that the eyes of leaders of industry have been opened, so that the intimate connection between science and commerce can be clearly seen. The discussion which took place at the Manchester City Council upon the report of the deputation, fully bears out the views expressed by Dr. Armstrong in his recent articles in NATURE on the need of organising scientific opinion (vol. lv. pp. 409, 433). Moreover, it shows that a large number of manufacturers are well able to understand that the reason for the prominence of some of the continental Powers lies in the educational system. It is evident that the report has given Manchester people a clear view of the direction in which advance should be made, and doubtless they will profit by it. Other municipal authorities would do well to send their wise men into the Fatherland for the lessons to be learned if they wish to make industrial progress.

PROF. G. H. DARWIN has gone to the United States to give a course of ten lectures on "Tides" at the Lowell Institute.

A SEA-FISHERIES exhibition, arranged to illustrate the fishing industries and the application of science to agriculture, will be opened in the Museum of Zoology, University College, Liver-

pool, to-morrow, by Mr. John Fell, chairman of the Lancashire Sea-Fisheries Committee.

PROF. F. OMORI, of the Seismological Institute, Tōkiō, is now in India, for the purpose of investigating the recent Calcutta earthquake, and reporting on the same to the Japanese Government.

THE Departmental Committee recently appointed to consider and report upon the desirability of establishing a National Physical Laboratory, and the functions which such an institution would perform, has just commenced its sittings.

WITH the last issue of our contemporary *The Electrician*, Mr. Bond's nine and a half years' connection with that journal ceased. Mr. W. G. Bond joined the editorial staff in April 1888, and was appointed editor in April 1895, upon the retirement of Mr. Alex. P. Trotter.

THE United States Board of Geographical Nomenclature have lately come to the following decisions about the orthography of some names brought into prominence through the Klondike gold discoveries:—Klondike will be spelt this way and not Clondyke or Klondyke, Lake Lebarge is adopted instead of Lake Labarge, Lake Lindeman instead of Lake Lindemann or Linderman, the Lewes river and not the Lewis river, and Taiya instead of Dyea, to denote the inlet, river, and village at the head of the Lynn Canal.

WE regret to receive confirmation of the report, already referred to, that Dr. J. Hann, Director of the Austrian Meteorological Service, has resigned that arduous position, from considerations of health, and has been appointed by the Minister of Instruction, &c., to the Professorship of Meteorology at the University of Graz. We have very frequently had occasion to notice Dr. Hann's valuable labours in our columns, and we may hope that now he is relieved from the onerous routine duties of such a large organisation he may be able to continue his studies for the benefit of meteorological science. His place in Vienna will be worthily filled by Dr. J. M. Pernter, late Professor of Meteorology at Innsbrück University, and the author of several meteorological publications.

THE Paris correspondent of the *Times* states that the value of the collections bequeathed by the late Duc d'Aumale to the Institute of France is officially reported to be 15,000,000 francs. Of this sum, 1,500,000 francs represents the additions made by the Duke subsequent to his deed of gift. The library alone, with its 28,000 volumes and 1400 manuscripts, is worth 5,000,000 francs. The receipts from lands, fisheries, timber, &c., are estimated at 400,000 francs per annum, which will leave a surplus of 40,000 francs over the outgoings. Annuities, moreover, to the Crédit-Foncier, now amounting to 86,000 francs, will expire in 1934. The Institute will enter next spring into possession of this princely bequest.

THE Duchess of Portland, president of the Society for the Protection of Birds, has written a special letter of appeal for increased funds to enable the Society to establish a small permanent office in London. More annual subscribers are wanted, and as an inducement it is proposed to designate as Fellows all who subscribe not less than one guinea per annum.

A GREAT physiologist, Dr. Rudolf Heidenhain, professor of physiology in the University of Breslau, has just passed away. From a notice of his life and work in the *British Medical Journal*, we derive the following particulars of his career:—Heidenhain was born in Marienwerder on January 29, 1834, and was thus just over sixty-three years of age at his death. He studied medicine at Berlin, Königsberg, and Halle. In Berlin he attended the lectures of Du Bois-Reymond, and in Halle those of F. W. Volkmann. He graduated at Berlin in 1854, and in 1859 he was called to the chair of Physiology and Histology in Breslau, a post which he held throughout his life. The early fruits of his labours and that of his pupils in Breslau appeared in his "Studien des physiologischen Institutes zu Breslau," in four volumes, from 1861 to 1868. Before that time, however, he had published his "Physiologische Studien" (1856). The first volume of "Pflüger's Archiv für d. gesammte Physiologie" appeared in 1868. In this "Archiv," from the second volume onwards, we have numerous papers from his laboratory, by himself, by his pupils, and by his assistants, including such diverse topics as the influence of the nervous system on temperature, metabolism in muscle, arhythmical activity of the heart, action of drugs on the nerves of the submaxillary gland, for example, atropine, calabar bean, nicotin, digitalin; his histological observations on the structure of the pancreas, wherein he showed the changes in gland cells that accompany secretion; the action of stimulation of sensory nerves on blood pressure, both by himself and in conjunction with his pupil Grützner, now professor of physiology in Tübingen; spinal reflexes; the innervation of blood vessels, a continuation of Ostroumoff's work on the same subject. In 1883 appeared his essay, "Physiologie der Absonderungsvorgänge," in vol. v. of Hermann's "Handbuch d. Physiologie." This is still a standard essay on this subject, and it contains an account of his researches on the salivary, pancreatic, gastric, and other glands. The whole series extends to over four hundred pages. His results are incorporated in every text-book on physiology. These essays record a masterly array of work dealing both with the physiological and the histological aspects of the question, and there stands out the pre-eminent fact that in all glands secretion is accompanied by characteristic structural changes. In later years came his now well-known researches on lymph formation, in which he attributed such great importance to the activity of the capillary wall as secretory organs. From his laboratory have appeared that long and important series of studies on hæmodynamics, by his assistant, K. Hürthle, while from the chemical department under Prof. Rohmann has come a whole series of important memoirs, many of them dealing with ferment action, which at present is attracting so much attention. Throughout the whole of Heidenhain's researches we have exemplified the value of conjoint histological, chemical, and more purely physiological work, the one serving to elucidate the other. Heidenhain was an admirable example of an "all-round" physiologist who did not work in a limited groove, but had a wide and comprehensive grasp of his subject, and, directly by his own work and indirectly by that of his pupils, added innumerable stones to the stately building of physiological science.

MANY of the scientific societies commence the new session next week. On November 2, a short address will be given at the Institution of Civil Engineers by Sir J. Wolfe Barry, K.C.B., F.R.S., and the medals and prizes awarded by the Council will be presented.—A meeting of the Institution of Mechanical Engineers will be held on November 3 and 4. The chair will be taken by the President, Mr. E. Windsor Richards, at 7.30 p.m. on each evening. The following papers will be read and discussed, as far as time permits: Experiments upon propeller ventilating fans, and upon the electric motor driving them, by Mr. W. G. Walker; diagram accounts for engineering work, by Mr. John Jameson; mechanical features of electric traction, by Mr. Philip Dawson.—The Chemical Society meets on November 4, when papers by Profs. Moissan and Dewar will be read (see p. 596).—The Society of Chemical Industry will meet on November 1, and papers will be read on (1) the adulteration of Portland cement, by Messrs. W. H. Stanger and Bertram Blount; (2) an improved adjustable drip proof Bunsen, by Dr.

W. P. Evans.—The first meeting of the Linnean Society for the new session will take place on November 4. Papers will be read by the Right Hon. Sir John Lubbock, Bart, F.R.S., on the attraction of flowers for insects; and by Mr. W. C. Worsdell, on transfusion-tissue, its origin and function in the leaves of gymnospermous plants; Mr. F. G. Jackson will show some zoological and botanical exhibits collected by the Jackson-Harmsworth Polar Expedition; and Mr. Reginald Lodge will exhibit lantern-slides of marsh-birds and their nests, from photographs recently taken in Spain and Holland.—The Geologists' Association will hold a conversazione at University College on Friday, November 5, when a number of interesting objects will be exhibited by some of the members.—The opening meeting of the new session of the Röntgen Society will be held at St. Martin's Town Hall on November 5. Prof. Sylvanus Thompson will deliver the presidential address.

THE new session of the Royal Geographical Society will open on November 8 with a brief introductory address by the President, and a paper on the Jackson-Harmsworth Arctic Expedition, by Mr. Frederick J. Jackson. On November 22 Dr. Sven Hedin will give an account of four years' exploration in Central Asia. Other papers which may be expected during the session are the following:—Exploration in Spitsbergen, 1897, by Sir W. Martin Conway; exploration in the Chilian Andes, by Mr. E. A. FitzGerald; explorations in Greenland, by Lieut. Peary; researches in the Scottish Lakes, by Dr. John Murray, F.R.S.; the Eastern Malay Provinces of Siam, by Mr. H. Warrington Smyth; a trip in Northern Somaliland, by Mr. F. B. Parkinson and Lieut. Brander-Dunbar. During the session it is probable that a special meeting will be held in connection with the 400th anniversary of the discovery of the Cape route to India by Vasco da Gama. Under the joint auspices of the Society and the London University Extension Committee, Mr. H. J. Mackinder is giving a course of twenty-five lectures on the geography of Britain and the British Seas, at Gresham College, Basinghall Street, E.C. It is probable that arrangements will be made for two Christmas lectures to young people, by Dr. H. R. Mill.

ON the 17th, 18th and 19th inst., the Liége Association of Engineers, a society composed exclusively of graduates of the Liége School of Mines, celebrated its fiftieth anniversary. Six hundred members took part in the celebration, as well as delegates bearing addresses of congratulation from the Iron and Steel Institute, the French Society of Engineers, the German Ironmasters' Association, and numerous other continental technical societies. The guests were received by Mr. R. Paquot, the President, who was one of the founders of the Association. After a brief presidential address, Prof. A. Habets, the indefatigable secretary, read a paper summarising the history of the first fifty years of the Association. The meeting was then divided into two sections, one dealing with mining and the other with metallurgy. In the former the following papers were read: (1) The development of the mining industry of Belgium since 1831, by Mr. E. Harzé; (2) a contribution to the geology of the Charleroi district, by Mr. J. Smeysters; (3) winding from great depths at the Harpen Collieries, by Mr. E. Tomson; (4) the economy due to steam compression, by Mr. V. Dwelshauvers-Dery and Mr. E. Hubert; and (5) continuous breaks, by Mr. A. Kapteyn. In the metallurgical section the papers dealt with were: (1) a study of the blast-furnace, by Mr. G. Rocour; (2) the progress accomplished in the knowledge of steel, by Mr. A. Greiner, of the Cockerill Company; (3) the direct utilisation of the gas of blast-furnace for the production of motive power; and (4) notes on steel, by Mr. J. Magery, of Aix-la-Chapelle. In the evening a banquet was held at the Royal Conservatoire, at which the Belgian Minister of Public Works and the Minister of Foreign Affairs were present. October 18 was devoted to excursions to Cockerill's Works, to the Small Arms Factory at Herstal, and to the University laboratories, a concert being held in the evening. October 19 was devoted to a visit to the Brussels Exhibition, where a farewell luncheon was held.

IN view of assertions which have been published, with some appearance of authority, as to the efficacy of sanitation as a substitute for vaccination in dealing with small-pox, the following opinions, from a declaration, signed by upwards of 850 medical officers of health in Great Britain, India, and the Colonies, and issued by the Jenner Society, are worth putting on record: (1) As responsible sanitary officials, to whom the care of the health and lives of the community is especially entrusted, we have every inducement to give due weight to the value of "sanitation" in the widest sense of the term for the prevention of small-pox as of other forms of infectious disease. We include in that term good drainage, the removal of refuse, the supply of pure air and water, and all other conditions which are calculated to fortify the body against disease in general. (2) We are no less alive to the importance of those special precautionary measures which experience has shown to be so valuable, when effectively used, to arrest the spread of infectious disease, such as the immediate notification of illness, the efficient isolation of the sick and of those who have been exposed to infection, and thorough disinfection of persons and things. (3) While thus fully appreciating the value of these agencies for such purposes, we unhesitatingly declare our belief that they cannot alone be relied on either to prevent or to stamp out epidemics of small-pox. (4) We believe that the only trustworthy protection at present known against small-pox, alike for the individual and the community, is efficient vaccination in infancy and subsequent re-vaccination, and that the only effective way of stamping out epidemics of this disease lies in the free use of these agencies.

WHETHER X-rays exist in the kathodic pencil which produces them is a question that forms the subject of some interesting experiments at the hands of Prof. A. Ròiti (*Atti dei Lincei*, vi. 5). To put the matter briefly, a discharge-tube was closed at one end by a plate of aluminium covered by a diaphragm of lead with a central aperture, in such a way that when kathodic rays fell on the central portion, the X-rays given off illuminated an actinometer. On placing the tube in the field of a powerful magnet, so as to deflect the kathodic rays to one side, the actinometer appeared almost dark. By inserting a tube of lead *inside* the discharge tube, so as to prevent any reflected rays from the side of the tube from reaching the central portion of the aluminium, complete extinction of the X-rays was obtained. The author concludes that indeflectable kathodic rays either are non-existent, or else, if they exist, are not transformable into Röntgen rays. Prof. Ròiti also describes experiments establishing the law that metals of greatest atomic weight emit rays of greatest intensity.

THE Commission appointed to inquire into the practicability of effecting electrical communication between light-houses and light-vessels and the shore, have issued their fifth and final report. They state that the system which has been in use for connecting the *Sunk* light-vessel with the shore is the best system of continuous connection which has been brought to their notice, but they do not consider it as affording an entirely satisfactory solution of the difficulty of maintaining in an efficient manner, and at a reasonable cost, electrical communication with light-vessels anchored in deep water and in exposed positions. Attention has been directed to the method of signalling without wires on the system used by Signor Marconi, but the Commissioners have not thought it desirable to make

any definite recommendations as to this until further light has been thrown on the matter by the investigations now being conducted by the Post Office. Experiments which have been made at the instigation of the Commissioners proved satisfactory, communication having been obtained without the aid of intermediate wires between two points on either side of the Bristol Channel, distant about nine miles from one another, and it has further been arranged for a practical trial of the system at a light-vessel.

In the *Journal de Physique* for October, M. Henri Becquerel's explanation of the experiments of M. Le Bon on the so-called black light (*lumière noire*) is given. M. Becquerel finds that all the observed phenomena can be attributed to the action of ordinary red and infra-red rays. Not only is ebonite transparent to such rays, but they possess the property of extinguishing the phosphorescence of sulphide of zinc, and of acting on a slightly "fogged" photographic film in exactly the manner observed by Le Bon. Moreover, when the ebonite is replaced by a sheet of red glass the same phenomena are observed.

We have received the first number of a new series of the "Publications of the University of Pennsylvania" devoted to mathematics. It contains "Contributions to the Geometry of the Triangle," by Robert Judson Aley, and "Properties of the Locus r = constant in Space of n Dimensions" by Paul Renno Heyl. In the latter, the author finds expressions for the measure of the content of the locus of the extremity of unit radius vector, and arrives at the result that this content is a maximum in the case of five-dimension space. A corresponding maximum is also shown to exist for the measure of boundary of the same locus.

The Corporation of Bristol, as owners of the port and docks built at Bristol and at Avonmouth and Portishead, are making great efforts to draw to the port some of the enormous trade which is now carried on between this country and the United States and Canada. At one time the port of Bristol stood first as the great centre for all the trade with the countries on the other side of the Atlantic, but gradually as the size of vessels increased, and as other ports improved their shipping facilities while Bristol practically stood still, the trade was directed principally to Liverpool, and more recently also largely to Southampton. However, owing to improvements which have been carried out at Avonmouth, a large firm of shippers have now commenced to run a regular line of steamers between Canada and Bristol, and cargoes of 8000 tons of miscellaneous merchandise have been quickly and efficiently discharged at the Avonmouth Dock. To further foster and secure this growing trade, the Corporation have recently decided to apply to Parliament for power to expend a million and a half of money in building a new and enlarged dock of 40 acres, which is to have an entrance lock 850 feet long, capable of receiving the largest steamers at present likely to be built.

Among various important articles in the *Annalen der Hydrographie und maritimen Meteorologie* for September, there is one of special interest, by Dr. G. Schott, on the fogs of the Newfoundland Banks. Fogs are prevalent in various parts of the world, but there is no district in which navigation is endangered in a similar way by the combination of icebergs and fog. The author has shown the distribution of fog upon twelve monthly charts, compiled from all the materials collected by the Deutsche Seewarte, for the routes of steam vessels between New York and 40° west longitude. The charts show that the period of most copious fog is from April to August inclusive; in September there is a sudden and considerable decrease, while February has the least amount. There are two regions in the district under consideration which have the greatest frequency of fog, viz. south of Nova Scotia and the eastern part of the Great Newfoundland Bank. On the Bank itself, especially on the western side, the frequency of fog is much less, owing to the water being considerably warmer there than on the eastern side, and because the sudden changes of the sea temperature do not occur there to the same extent as on the eastern side, where the two currents come into contact.

A suggestive paper by Prof. W. P. Mason, entitled "Sanitary Problems connected with Municipal Water Supply," has been published in the *Journal* of the Franklin Institute. Some interesting facts are recorded concerning the health of some American cities in relation to typhoid fever and water supply. The writer tells us that the average annual typhoid death rates for thirteen Massachusetts cities before the introduction of a public water supply was 7·94 per 10,000, whilst since the improvements have been carried out the deaths from typhoid fever have fallen to 3·83 per 10,000. In the whole State of Connecticut the percentage of typhoid deaths to total deaths has fallen from about 5·8 in 1870 to 1·84 in 1893. But although much advance has been made in the improvement and protection of American public water supplies, a great deal remains yet to be done. A source of pollution too often overlooked is the contamination of water in the pastures through which it passes. Mason cites an instance which came under his notice of twenty-six cows in a pasture through which ran the open watercourse connecting the storage and distributing reservoirs of a city. The animals had perfect freedom to wade in the stream to within a few yards of the point where the water entered the city mains. A very remarkable example of how typhoid fever may be spread is given in the case of a serious outbreak of this disease which took place at Plymouth, Pa. The origin of this disastrous epidemic was traced to a single typhoid patient whose dejecta were thrown out upon the snow of a frozen hillside, at the base of which ran a small stream, whence the town water supply was ultimately drawn. Several weeks elapsed, during which the dejecta were hard frozen before the March thaws permitted the melting snows to wash them into the stream below; but during this interval the typhoid germs had retained their vitality and full complement of virulence, as demonstrated by the otherwise quite unaccountable outbreak of typhoid fever in the said town. Various investigators have shown that typhoid bacteria can stand being frozen; indeed, it has been found that three months' continuous freezing does not destroy these germs.

A Louisiana Society of Naturalists has been established, with about forty-five members. The Secretary is Mr. E. Foster, of New Orleans.

A. Vierkandt gives in *Globus* (Band lxxii. p. 133) a long and illustrated account of Ehrenreich's "Anthropologische Studien über die Urbewohner Brasiliens." The evidence seems to these authors to show that the American Indians are a distinct race of mankind, and not a branch of the Mongolian race.

The primitive inhabitants of India in their ethnological, religious and linguistic aspects, is the subject of two illustrated articles in *Globus* (Band lxxii. p. 53, 77), by Prof. Gustav Oppert. This is a preliminary sketch of a memoir that the author is preparing, and which promises to be of considerable importance.

In a collection of fifteen skulls from the Papuan Gulf, Dr. G. A. Dorsey (*Dental Review*, Chicago, vol. xi.) finds three examples of suppressed third molars and two examples of supernumerary pre-molars. The occurrence of the latter looks like an atavism, while the absence of the wisdom-tooth is

generally regarded as due to a reduction of the jaw, and therefore, to a certain extent, is a result of civilised or cultural habits.

THE affinities of the Hovas of Madagascar have often been discussed. A recent paper by Mr. Duckworth (*Journ. Anth. Inst.*, 1897, p. 285) gives occasion to Zaborowski (*Bull. Soc. Anthrop.*, viii. p. 84) to review this problem; he points out various difficulties in deriving the Hovas from a pure Malay stock, and draws attention to numerous resemblances with the Nias. The latter are by no means pure Battaks, and Modigliani believes in an Indian influence. Zaborowski endeavours to show that this is largely Dravidian (rather than Aryan), and hints that this is also indirectly felt among the Hovas.

DURING next month the following science lectures will be delivered at the Royal Victoria Hall, Waterloo Bridge Road, on Tuesday evenings:—November 2, "Across Spitsbergen," Dr. J. W. Gregory; November 9, "Impressions of Canada," Prof. Beare; November 16, "Indian Meal and English Yeast," Mr. J. A. Baines; November 23, "The Gas Helium, and how it was discovered," Prof. Ramsay, F.R.S.; November 30, "Speech," Dr. B. L. Abrahams.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Miss A. E. Ard; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Miss Shone; two Weka Rails (*Ocydromus australis*) from New Zealand, presented by Mr. Forbes White; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mr. Aitchinson; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Crowned Lemur (*Lemur coronatus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, a Diademed Amazon (*Chrysotis diademata*) from South America, deposited; two Trumpeter Swans (*Cygnus buccinator*) from North America, a Crested Grebe (*Podiceps cristatus*), European, purchased; a Wapiti Deer (*Cervus canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

STARS IN THE LARGE MAGELLANIC CLOUD.—The Henry Draper Memorial has been the means by which it has been ascertained that the spectra of those stars belonging to Pickering's fifth type, and consisting mainly of bright lines, have hitherto been found only near the central line of the Milky Way. Out of the sixty-seven stars which come under this category, their mean deviation from this line amounts to the remarkably small angle of 2° 39′, while only one object deviates more than 9°. Prof. Pickering now points out that the two Magellanic clouds closely resemble the Milky Way in appearance, although both are detached from it and distant from the central line above mentioned by about 30° and 45°. A recent examination, by Mrs. Fleming, of the spectra of the stars in the large cloud (*Harvard College Circular*, No. 19), obtained by means of the Bruce photographic telescope, has shown that six stars have been discovered whose spectra are of the fifth type; further, that in seven stars of Pickering's first type, bright hydrogen lines are present, while the spectra of six known nebulæ are gaseous and not continuous. The *Circular* gives a list of the positions of these objects, but their declinations are too far south to be worth repeating here. It is interesting to note that Dr. Stewart in Peru independently observed the presence of bright lines in twelve of these objects, and communicated his results to Prof. Pickering while the *Circular* was in preparation.

THE PHOTOGRAPHY OF DELICATE CELESTIAL PHENOMENA.—Will one ever be able to satisfactorily record the details on planetary discs by the aid of photography? Dr. T. J. J. See says an emphatic No, while Prof. F. L. O. Wadsworth says very probably Yes. The former, writing in the *Astr. Nachr.* (No. 3449), bases his answer on the effect of the motion of the air, which shifts at insensible intervals the positions of the images by measurable quantities. By uninterrupted observation the eye becomes capable of detecting very delicate phenomena at the occasional moments of good seeing, and the mind, without any special effort, "readily determines what is permanent and what is transient." The photographic plate has a cumulative power, and the partial images are superposed with the result that the developed plate is impressed with an enlarged and blurred image, which gives nothing but the average result for the whole time of exposure. Further, Dr. See points out that small details cannot be photographically recorded because, even if there were no spreading of the light on the plate, no bodily motion of the whole image, and the motion of the telescope were perfect, phenomena smaller than 0″·5 could not be recorded. Thus, he says, "it does not seem possible that anything requiring even a moderate exposure could be detected in a luminous field (where the contrast is very great) when the diameter of the image is less than 1″."

Prof. Wadsworth (*Astronomical Journal*, No. 414) thinks, on the other hand, that photography up to the present time has failed only because the particular ways in which it has been applied have not been perhaps the best to secure the most satisfactory results. "There seems to be no good reason why we should not, under proper conditions, photograph all or even more (on account of greater resolving power and greater light action) than we can ever be sure we really see (up to a certain size of aperture not greater than 12 to 15 inches) on a planetary surface." The unsteadiness of the image during exposure, which is the main difficulty, he proposes to practically eliminate by mounting the photographic and the observing telescope on the same stand, and exposing the plate only for those intervals when the seeing is the best and the image steady. As Prof. Wadsworth is engaged in experiments in this direction, it would be perhaps more satisfactory to await his results. The problem is, however, of great interest and well worth solving.

COMET PERRINE, OCTOBER 16.—From Kiel we have received a *Centralstelle Circular* (No. 1), in which we are informed that Prof. Schaeberle has telegraphed the elements and ephemeris computed by Messrs. Hussey and Aitken from observations made on October 16, 17 and 18. A later *Circular* (No. 2) gives us the elements and ephemeris as calculated by Prof. H. Kreutz and Herr Möller from the observations made on October 16, 18 and 20. Below we give the two sets of elements mentioned above, together with the ephemeris printed in the second *Circular*:—

Elements.

T = 1897 Dec. 9·23 G.M.T.	T = 1897 Dec. 7·799 Berlin M.T.
$\varpi = 66°\ 28'$ } 1897·0	$\varpi = 65°\ 4'·2$ } 1897·0
$\Omega = 32\ \ 5$ }	$\Omega = 31\ \ 57·9$ }
$i = 69\ \ 38$ }	$i = 69\ \ 26·5$ }
$\log q = 1·3525$	$\log q = 0·13440$

Ephemeris for 12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl.	log *r*.	log Δ.	Br.
Oct. 28	0 5 20	+81° 24′·7	0·1716	9·9072	1·1
29	23 23 35	81 41·0	1700	9093	1·1
30	22 41 27	81 40·1	1683	9116	1·1
31	22 1 40	81 22·7	1667	9141	1·1
Nov. 1	21 26 4	80 51·6	1652	9170	1·1
2	20 55 44	80 9·5	1636	9201	1·1
3	20 30 21	79 19·7	1621	9234	1·1
4	20 9 25	78 24·3	1606	9270	1·1
5	19 52 8	77 25·3	1592	9307	1·0
6	19 37 51	+76 24·2	0·1577	9·9346	1·0

The comet's position is now very favourable for observation, lying to the north of the constellation of Cepheus, passing on October 29 between γ Cephei and the Pole Star; its distance from the former of these being equal to about a quarter of the distance between the two stars.

DR. B. ENGELHARDT'S OBSERVATORY.—We notice in the current number of the *Astronomische Nachrichten* (No. 3450) that, through age and ill-health, Dr. Engelhardt is compelled to discontinue his astronomical labours, and has given up his observatory at Dresden. He has presented all the instruments and the library to the Russian Royal University Observatory at Kasan.

SCIENCE AND MODERN CIVILISATION.[1]

WHEN Harvey was entering on his career as an investigator, in the early years of the seventeenth century, the great movement of the Renaissance had produced its full effects. Starting in Italy in the fourteenth century, it spread during the fifteenth and sixteenth centuries and permeated the rising nationalities of Western Europe. It was through the zeal engendered by this movement that the priceless literary and artistic treasures of Greece and Rome were rescued from oblivion and made the secure heritage of all time. The study of these monuments of ancient genius, and the inspiration communicated by them, saved mediæval Europe from barbarism, and created a new civilisation not inferior in polish to that of the classical ages. Upon literature and the fine arts the spirit of the Renaissance reacted with the happiest possible effects. It inspired the masterpieces of poetry, painting, architecture, and sculpture, which constitute the glory of the fifteenth and sixteenth centuries, and compel the admiration and challenge the rivalry of the nineteenth century. But, as regards natural knowledge, the influence of the Renaissance was at the first, and even for a long time, distinctly unfavourable. The writings of Hippocrates, Aristotle, Ptolemy, Galen and other masters were studied and searched, not for inspiration to new inquiry and higher development—but these great names were erected into sacrosanct authorities, beyond whose teaching it was vain, and even impious, to seek to penetrate. The result of this perversion was that the pursuit of natural knowledge degenerated into sterile disputations over the words of the masters. This numbing despotism of authority comatosed the intellect of Europe during many generations. It received the first rude shocks from the discoveries of the great anatomists of the sixteenth century; and it was finally overthrown by the force of the demonstrations of Galileo and Harvey—powerfully aided, no doubt, by the philosophical writings of Bacon and Descartes.

These four men—Galileo, Harvey, Bacon, and Descartes—were the dominating spirits of their epoch in the sphere of natural knowledge; they were contemporaries; and three of them must have had more or less personal acquaintance with each other. Harvey was Bacon's friend and physician; and we can easily believe that much talk went on between the investigator and philosopher concerning the studies in which they were mutually interested—and that Bacon imbibed his enlightened notions respecting the importance of experiments in the pursuit of knowledge from the precepts and practice of Harvey. It does not appear that Descartes was personally known to Harvey, but he was one of the earliest to accept the doctrine of the circulation, and to write in its defence. When Harvey was a student at Padua, Galileo occupied the chair of mathematics in that university. These two men take rank as the twin founders of modern science—the one in the domain of biology and the other in the domain of physics. Their lives largely overlapped; they were contemporaries for sixty-four years, and both nearly reached the patriarchal age of fourscore. Roughly speaking, their period of activity covered the first half of the seventeenth century. They were, each in his respective department, pioneers in the method of searching out the secrets of nature by observation and experiment, and in proclaiming the paramount necessity of relying on the evidence of the senses as against the dicta of authority.

The present year is the 300th anniversary of Harvey's graduation at Cambridge, and of the commencement of his career as a student and investigator of nature. That date, 1597, corresponds roughly with the birth-time of modern science. The occasion is, therefore, not inappropriate for a survey of the changes impressed upon civilised society by science—after three centuries of expansion and growth. The lapse of time is sufficiently long, and the advance made is sufficiently great, to enable us to estimate approximately the scope and strength of this new factor in our environment; and perhaps even to appreciate the influence which the cultivation of science is likely to have on the future of modern civilisation.

All the older civilisations have issued either in extinction, or in permanent stagnation. The civilisations of Egypt and Chaldæa and of Greece and Rome, after a phase of progressive decline, eventually perished by military conquest. The ancient civilisations of the Far East—those of India and China—still persist, and have a semblance of life; but it is a life of helpless torpor and immobility. Is our modern civilisation doomed to share a kindred fate? There are, I think, good reasons for believing that in this respect history will *not* repeat itself. Special features are observable, and special forces are at work, in contemporary civilisation which differentiate it profoundly from all its predecessors.

It may be said, broadly, that the older civilisations rested essentially upon art and literature (including philosophy)—and that modern civilisation rests, in addition, upon science and all that science brings in its train. This distinction is, I think, fundamental—and connotes a radical difference as regards stability and continuance between ancient and modern society. A comparison of the mode of growth of the fine arts and literature on the one hand, with the mode of growth of science and its dependent useful and industrial arts on the other, brings out this point very clearly.

The evolution of literature and art displays the following well-marked characteristics. Starting from some rude beginnings, each branch of literature and each branch of the fine arts grows by a succession of improved ideals until a certain culminating level of excellence (or phase of maturity) is attained. When this level is reached no further growth takes place, nor even seems possible. The level of excellence attainable by any nation depends presumably upon the measure of the original endowment of the race with artistic and literary faculty. When and after this summit level of excellence is achieved, all subsequent expansion, if any, is quantitative rather than qualitative—and consists in modifications, variations, repetitions and imitations—but without any real advance in artistic and literary excellence. It may be further noted that there is observable in the past annals of literature and the fine arts a fatal tendency to a downward movement. The variations are apt to show meretricious qualities—which indicate, in the judgment of critics, a degradation from the high standard of the earlier masters. The life of each of the fine arts seems, as Prof. Courthope has expressed it, to resemble the life of an individual in having periods of infancy, maturity and decline. The witness of history bears out this view.

It is almost startling to consider how long ago it is since most branches of art and literature had already reached their highest known pitch of excellence. The Homeric poems are supposed to have been composed a thousand years before the Christian Era—and no one doubts that as examples of epic poetry they still stand in the front rank. In the fourth and fifth centuries B.C. there occurred in Greece an extraordinary outburst of artistic and literary genius—such perhaps as the world has never seen before nor since. During this epoch sculpture was represented by Phidias and Praxiteles—architecture by the builders of the Parthenon—painting by Apelles and Zeuxis—dramatic poetry by Sophocles, Euripides, and Aristophanes—and speculative philosophy by Plato and Aristotle. Greece maintained her political independence for two centuries after this period; but she did not produce anything superior, nor apparently even equal, to the masterpieces of this golden age.

A parallel sequence is observable in the history of Ancient Rome. Art, literature, and philosophy—and all studies that may be grouped under these headings—attained their culmination in the Augustan age; and no advance thereupon took place, but rather a falling off, during the subsequent centuries of imperial Rome's political existence.

If we turn our eyes to the Far East we see that the masterpieces of architecture and ornamental metal work, and of poetic and philosophical literature are all old—many of them very old. Neither in India nor China nor in any other Far Eastern country are there any indications of advance for many centuries in the domain of artistic and literary culture.

The history of Western Europe tells a similar tale. The finest examples of Gothic and Norman architecture date from the twelfth and thirteenth centuries. Painting culminated in Italy during the fifteenth and sixteenth centuries with Raphael, Da Vinci, Correggio, Titian, and Paul Veronese. The same art reached its highest level in the Low Countries with Rembrandt and Rubens—in Spain with Velasquez and Murillo—in France with Claude Lorraine and Poussin—all artists who flourished in the seventeenth century. In England nothing greater than the works of Reynolds, Gainsborough, and Turner has been produced by later artists. Similarly with literature: most of the masterpieces belong to a past age. Italy can show no higher examples of poetry than the creations of Dante,

[1] Extract from the Harveian Oration, delivered before the Royal College of Physicians, October 18, by Sir William Roberts, M.D., F.R.S., Fellow of the College.

Petrarch, Tasso, and Ariosto. The most ardent admirers of the Victorian poets would scarcely contend that any of them stand on a higher pedestal than Shakespeare and Milton; nor would any German critic claim equality for any recent poet of the Fatherland with Goethe and Schiller. In the delightful art of music, the masterpieces of Haydn, Handel, and Mozart, judging by their popularity at the present day, are not surpassed by the works of any of the later musical composers.

I need not pursue the subject in greater detail. Wherever we look—in all ages, among all peoples—we encounter the same story with regard to that large and varied and most precious outcome of the human mind which may be grouped under the categories of the fine arts and literature. There is a history of improvement and growth up to a certain culmination, or phase of maturity. Beyond that point no further growth seems possible—but rather, instead, a tendency to decline and decadence.[1]

The evolution of science differs fundamentally from that of literature and the fine arts. Science advances by a succession of discoveries. Each discovery constitutes a permanent addition to natural knowledge—and furnishes a post of vantage for, and a suggestion to, further discoveries. This mode of advance has no assignable limits; for the phenomena of nature—the material upon which science works—are practically infinite in extent and complexity. Moreover, science creates while it investigates; it creates new chemical compounds, new combinations of forces, new conditions of substances, and strange new environments—such as do not exist at all on the earth's surface in primitive nature. These "new natures," as Bacon would have called them, open out endless vistas of lines of future research. The prospects of the scientific inquirer are therefore bounded by no horizon—and no man can tell, nor even in the least conjecture, what ultimate issues he may reach.

The difference here indicated between the growth of art and literature and the growth of science is, of course, inherent in the subjects; and is not difficult to explain. The creation of an artist, whether in art or literature, is the expression and embodiment of the artist's own mind—and remains always, in some mystic fashion, part and parcel of his personality. But a scientific discovery stands detached; and has only an historical relation to the investigator. The work of an artist is mainly subjective—the work of a scientific inquirer is mainly objective. When and after a branch of art has reached its period of maturity, the pupil of a master in that art cannot start where his master ended, and make advances upon his work; he is fortunate if at the end of his career he can reach his level. But the pupil of a scientific discoverer starts where his master left off; and, even though of inferior capacity, can build upon his foundations and pass beyond him. It would seem as if no real advance in art and literature were possible except on the assumption that there shall occur an enlargement of the artistic and literary faculty of the human mind. No such assumption is required to explain and render possible the continuous advance of science. The discoverer of to-day need not be more highly endowed than the discoverer of a hundred years ago; but he is able to reach further and higher because he stands on a more advanced and elevated platform built up by his predecessors.

The fatal weakness of previous civilisations lay in the absence of any element which had inherent in it the potentiality of continuous growth and unlimited expansion—and this is precisely what exact science supplies to modern civilisation. A sharp distinction must be drawn between the so-called science of antiquity and the science of to-day. The ancients had a large acquaintance with the phenomena of nature, and were the masters of many inventions. They knew how to extract the common metals from their ores; they made glass; they were skilled agriculturists; they could bake, brew, and make wine, manufacture butter and cheese, spin, weave, and dye cloth; they had marked the motions of the heavenly bodies, and kept accurate record of time and seasons; they used the wheel, pulley and lever; and knew a good deal of the natural history of plants and animals, and of anatomy and practical medicine. This store of information had been slowly acquired in the course of ages—mostly through haphazard discovery and chance observation—and formed a body of knowledge of inestimable value for the necessities, conveniences, and embellishments of life. But it was not science in the modern sense of the word.[1] None of this knowledge was systematised and interpreted by coordinating principles; nor illuminated by generalisations which might serve as incentives and guides to further acquisitions. Such knowledge had no innate spring of growth; it could only increase, if at all, by casual additions—as a loose heap of stones might increase—and much of it was liable at any time to be swept away into oblivion by the flood of barbaric conquest.

1 If we take a wider view of the constituent elements of organised society—and embrace in our consideration the religious systems, the political and civil institutions, the military organisations, the commerce and the miscellaneous disconnected mass of natural knowledge existing in the older civilisations—we look in vain for any constituent which had more than a limited scope of expansion, and was not subject to decay.

It is quite obvious, from the subsequent course of events, that there came into the world of natural knowledge about three centuries ago, in the time of Galileo and Harvey, a something—a movement, an impulse, a spirit—which was distinctly new—which Bacon, with prophetic insight, termed a "new birth of time."

This remarkable movement did not originate with any startling revelation; it consisted rather in an altered mental attitude, and a method. There arose a distrust in the dicta of authority, and an increasing reliance on ascertained facts. These latter came to be regarded as the true and only data upon which natural knowledge could be securely founded and built up. Doubt and question took the place of false certainty. The hidden meaning of phenomena was sought out by observing them under artificially varied conditions—or, to use the words of Harvey, "the secrets of nature were searched out and studied by way of experiment." *A priori* reasoning from mere assumptions, or from a few loosely observed facts, fell into discredit. Observations were repeated and made more numerous and more exact. These were linked together with more rigid reasoning to stringent inductions. Hypotheses (or generalisations) were subjected to verification by experiment; and their validity was further tested by their efficacy in interpreting cognate problems, and by their power to serve as guides to the acquisition of fresh knowledge. Instruments of precision were devised for more accurate observation of facts and phenomena—for weighing and measuring, for estimating degrees of temperature, the pressure of gases, the weight of the atmosphere, and for recording time. The sense of sight was aided by means of the telescope and microscope. The invention of instruments and appliances for assisting research was an essential and invaluable feature of the "new philosophy." It is singular that so little progress in this direction was made by the quick-witted Greeks of the classical period; and their neglect or incapacity in this respect largely accounts for their conspicuous failure in science as contrasted with their brilliant success in art and literature.[2]

The new method soon began to yield fruit—at first slowly, then more and more rapidly as the workers increased in number, and the method was more fully understood. Discoveries were no longer solely stumbled on accidentally, but were gathered in as the fruit of systematic observation and purposive research. It is not necessary for me, even if I had the time and ability, to trace the history of scientific discovery from the time of Harvey onward. I will only mention a few particulars by way of illustration. You all know how, as time passed on and knowledge

1 "It is not a collection of miscellaneous, unconnected, unarranged knowledge that can be considered as constituting science."—*Whewell.*

2 Whewell observes ("History of the Inductive Sciences," vol. i. book 1, chap. iii.): "The Aristotelian physics cannot be considered as otherwise than a complete failure. It collected no general laws from facts; and consequently, when it tried to explain facts, it had no principles which were of any avail." Whewell argues that this failure was not due to the neglect of facts. He goes on to say: "It may excite surprise to find that Aristotle, and other ancient philosophers, not only asserted in the most pointed manner that all our knowledge must begin from experience, but also stated in language much resembling the habitual phraseology of the most modern schools of philosophising, that particular facts must be *collected*; that from these general principles must be obtained by *induction*; and that these principles, when of the most general kind, are *axioms*." Then he quotes passages in proof from Aristotle's writings. It is, however, pretty evident that Aristotle's reverence for facts was no more than a pious opinion, which he habitually ignored in the actual handling of questions of natural knowledge. His treatise "On the Parts of Animals" bristles with errors of observation which a very moderate amount of painstaking would have rectified. Had the ancient Greeks, and their successors in the middle ages, been more accurate observers of facts, and had they sought for and invented instruments for the more exact observation of facts, they would not have so conspicuously failed to establish at least the foundations of exact science. The historian of the inductive sciences, however, will have it otherwise. He sums up his argument thus: "The defect was that, although they had in their possession *Facts and Ideas, the Ideas were not distinct and appropriate to the Facts.*" Is it not rather the case that the "Ideas were not distinct and appropriate to the Facts," precisely because the "Facts" were indistinctly seen and imperfectly apprehended?

expanded, the primary sciences became divided into separate departments for more minute study—how new sciences have arisen, some of which have now grown to vast proportions—how improved instruments and appliances of infinite delicacy have been invented to aid research—and how, in the present age, the gains of pure science have been turned to innumerable channels of practical utility.

The advances made in physics and mechanics during the seventeenth and eighteenth centuries prepared the way for the invention and perfection of the steam-engine in the nineteenth century. The introduction of the steam-engine increased at a bound the power of the human arm many-fold.[1] Through its instrumentality the land has been covered with railways, and the sea with ocean steamers. Electrical science has given us the telegraph and telephone, a new illuminant, and a new motor. The steam printing press, the telegraph, and the railway together, have made it possible to produce that perhaps most wonderful of all the indirect outcomes of the growth of science—the modern newspaper. The great science of chemistry has revealed the composition of the material world; has originated vast industries, which give work and wages to millions of the population; and has placed all kinds of manufacturing processes upon a basis of scientific precision. Under cover of chemistry have sprung up the sub-sciences of photography and spectroscopy, which have given a new and unexpected development to our knowledge of the heavenly bodies. The revelations of palæontology and embryology have led to the establishment on a firm basis of the theory of organic evolution. This theory—by far the most penetrating generalisation of our time—has not only thrown a flood of light upon the deepest problems of natural history, but has also revolutionised the whole domain of speculative thought. Physiology and practical medicine have profited immensely by the general advance of the sister sciences, and by the adoption of scientific methods in the prosecution of research. Optical science gave birth to the achromatic microscope. The microscope has laid bare the minute structure of plants and animals, and introduced zoologists and botanists to a vast sub-kingdom of minute forms of life, previously undreamt of. The microscope also, in conjunction with chemistry, founded the new science of bacteriology. Bacteriology has inspired the beneficent practice of antiseptic surgery; it has also discovered to us the parasitic nature of zymotic diseases—and opened out a fair prospect of ultimate deliverance from their ravages.

Thus have the several sciences advanced, and are still advancing, in concert, step on step, by mutual help, at an ever-increasing speed pushed on by that irrepressible forward impulse which has characterised the scientific movement from its inception. This movement has now become the dominant factor in civilisation.

There is no doubt that, under the reign of science, a striking amelioration in the state of society has taken place. The mass of the people are better housed and fed—and, above all, better educated. Their sanitary surroundings are improved, and the death-rate has fallen. Crime and pauperism have diminished, and there is greater security for person and property. The amenities and enjoyments of life are on the increase, and the average scale of comfort is markedly raised. Moreover, this amendment is not confined to the material and physical well-being of the population. There is some evidence that the complex of conditions we term "modern civilisation" is acting favourably in the direction of making people more reasonable and better conducted. Peace is now the normal condition between civilised states; and there is a growing trend of opinion in favour of settling international differences by the more rational method of arbitration, rather than by war. Political morality approximates more nearly to that recognised as proper in private life. The duel has almost been laughed out of court. Industrial quarrels are conducted with more order; there is an appeal to facts and reason on both sides, and more readiness to adjustment by compromise.

The whole environment of modern life seems in several ways calculated to foster habits of correct thinking and acting. The inclusion of science in the scope of general education is a very important innovation. This extends the range of subjects in regard to which precise reasoning is possible; and tends to promote the application of scientific modes of thinking and reasoning to all the problems of life. We may be quite sure that exact thinking leads in the main to correct conduct; an evil deed is not only a crime, but also a blunder. The periodical press must, one would think, be a good training-school for thinking and reasoning. The discussion of all sorts of questions in its columns can scarcely fail to have an educating effect. The disputants must perforce read one another's arguments, and be, consciously or unconsciously, influenced thereby. It may be assumed, or at least hoped, that there is in arguments, as in organic forms, a tendency to the survival of the fittest—and that in the long run the better argument carries the day. The blaze of publicity amid which we live, through the ubiquitous newspaper, lends an additional motive to right-doing. The "fierce light which beats upon a throne" beats nowadays also upon the citizens, and doubtless helps to keep them in the straight path.

But, say the prophets of evil: "This will not endure; modern civilisation, based on science, will in time go the way of all its predecessors, and end in extinction or in decay and stagnation." It is proverbially unsafe to dogmatise about the future; and in all human affairs, even those termed scientific, there is nothing so certain as the unexpected. This, however, may be affirmed: that if modern civilisation is to come to an end, it will not perish in the same way, nor from the same causes, as previous civilisations.

One of the standing perils of civilised communities in ancient times was the risk of being subjugated by less civilised neighbours, or of being overwhelmed by hordes of barbarian invaders. This danger no longer threatens us. Power has passed for ever into the hands of the nations which cultivate science, and invent. The appliances of war are now placed on a scientific basis; and the issue of battle is decided in the laboratories of the engineer and the chemist. The late C. H. Pearson argued that the dark and yellow races, in virtue of their greater number and fecundity, might in time come to dispute the supremacy of the white races—that they would learn the drill and copy the armaments of European armies, and thus equipped would be able, by their superior mass, to hem in and curb, if not to subjugate, the Western nations. But the march of science and invention never stops; and it is inconceivable that the scientific nations shall not always be many stages in advance of the unscientific nations in the destructiveness of their weapons and the perfection of their military equipments—and this would give them an advantage which scarcely any disparity of numbers could neutralise. The "yellow terror" can never be more than a phantom until these races begin to show capacity for scientific discovery, and the further (and somewhat different) capacity for turning their discoveries to practical uses.

Against the more insidious peril of decay and stagnation the scientific movement seems also to offer effective safeguards. We sometimes hear complaints of the hurry and bustle—the stress and strain—of modern life; this unrest may incommode individuals—but it is the antiseptic of society. Probably the deadliest predisposing factor in the decline of former civilisations was the mental inanition arising from deficiency of fresh and varied intellectual pabulum. Physiological analogies lead us to the inference that an idle brain, like an idle muscle or an idle gland or nerve, would deteriorate in function; and, conversely, that a well-exercised brain would tend to reach its possible best. I conceive that our forefathers and the ancients, for the most part, led somewhat monotonous lives. They had but little fresh and varied food for thought. The generality could not, for lack of "news," take a sustained interest in the course of public events. The world of science was an unopened book. Intercommunication was slow and difficult; and the whole current of existence flowed sluggishly. Contrast this with the vivid abounding life of the present day. Veins of interest are greatly multiplied—to meet and satisfy the infinitely varied individual aptitudes of men and women. A considerable number of persons of both sexes now busy themselves, either as amateurs or something more, with the study of some branch of science or natural history. Those whose bent is to politics, art, letters, sport, or fashion, find in the daily newspaper and the periodical press an unfailing fresh supply of the mental food they love. Business and pleasure are carried on with a briskness formerly unknown, and the pulse of national life is quickened through every part. It seems impossible that decay should invade the body politic while such conditions of all-pervading activity prevail—and there is no valid reason why these conditions should not continue to prevail. It has often been remarked that

[1] Mr. Mulhall calculates that "our steam-power in the United Kingdom is equal to the force of 169,000,000 able-bodied men, a number greater than the whole population of Europe could supply."—*National Progress during the Queen's Reign*, p. 22.

periods of national upheaval, when men's minds are deeply stirred—like the rise of Islam, the Protestant Reformation, and the French Revolution—were exceptionally prolific of able men. It does not appear altogether unreasonable to suppose that the stir and movement of modern life may be similarly favourable to the production of "men of light and leading" for the service of the community. The proximate cause of the downfall of states seems always to have been a defective supply of strong and capable men at the head of affairs, and in positions of trust. The *dolce far niente* is not conducive to the formation of strong characters; and those who sigh and yearn for social quietism may find comfort in the reflection that the hum and buzz which disturbs them is a sure token of the health and strength of the common hive.

THE BEHAVIOUR OF ARGON IN X-RAY TUBES.[1]

IN continuation of some experiments made by Prof. Callendar in the early part of 1896, the authors have studied the behaviour of argon in X-ray tubes of various types. The phenomena presented by a tube filled with carefully dried and purified argon, are in many respects peculiar, as compared with those presented by other gases under similar conditions.

In the early experiments above mentioned it had been our custom to keep the X-ray tube connected with the pump, which was used as a reservoir of dry air during long exposures. The gas, which was absorbed by the working of the tube at a high vacuum and a long equivalent spark-gap, was restored from time to time, as the vacuum became too high, by letting a little air in from the pump by means of a convenient tap. In this manner it was possible to operate the tube at a very high rate of efficiency for two hours or more at a time. These long exposures were required for some experiments on the velocity of the X-rays, which have been described in a communication to the Canadian Royal Society, May 1896.

It was noticed on several occasions, after one of these long exposures, that there was considerable blackening and sputtering of the electrodes, and also that the pressure of the air in the tube had increased considerably above the degree of vacuum required for the production of X-rays when the tube was first exhausted. After allowing the tube to rest for a few hours, although there was very little increase in the pressure, it was also observed that no kathode rays were produced until the discharge had been passed for some time. It appeared probable that some of these effects, which are recorded in the paper above mentioned, were due to the accumulation of argon in the tube. The spectral lines of that gas were on some occasions faintly discernible in parts of the tube, but no systematic spectroscopic observations were taken.

In making further investigations on the behaviour of argon, we hoped to find that, owing to its natural inertness, the vacuum would be of a very permanent type as compared with other gases. We also hoped that its monatomic character would afford features of interest.

For the preparation and purification of the argon used in these experiments, the Cavendish spark method was adopted, as described by Rayleigh and Ramsay. For this purpose a special transformer was constructed, the primary and secondary of which were wound on different parts of the core. The primary was connected to the 100-volt lighting circuit. The secondary gave 10,000 volts on open circuit, available for starting the arc, but the voltage on the arc when running was only 2,000. The secondary could be short-circuited, owing to the arrangement of the winding, without materially increasing the current, or running any risk of burning up the coil. The apparatus could thus be left running safely by itself day and night without wasting any power on resistances. After concentrating the argon to about 60 or 70 per cent. in the flask, it was further purified in a test-tube apparatus, constructed so as to contain the minimum of liquid. The excess of oxygen was sparked off with hydrogen, and the residue removed by absorption with alkaline pyrogallate. The argon thus purified was kept in a bulb containing P_2O_5.

In the first set of trials of this argon in X-ray tubes, a Fleuss mechanical pump was used, which permitted very rapid exhaustion of the tubes, but had no arrangement for measuring the high vacua. The vacuum was estimated in these cases by the appearance of the tube and the width of the dark space.

The first tube tried had two aluminium electrodes, and had been lying open to the air for some time previously. It was exhausted and washed out two or three times with dry argon, and then sealed off at a good X-ray vacuum. Each operation occupied only two or three minutes, and the vacuum has since that date deteriorated slightly, probably owing to insufficient removal of residual gas from the electrodes, but it still gives sufficient light to see the bones of the hand. The tube during exhaustion presented exactly the same appearances, except in colour and spectrum, as if it had been filled with air.

The second tube had been worked up to a sparkless vacuum some weeks previously, and had been frequently renovated by heating. It had an aluminium kathode and a platinum anode. It was connected to the pump and exhausted as soon as possible after opening. It was then filled with dry argon up to a pressure of one-fifth millimetre, and exhausted to an X-ray vacuum five times in succession. The glow on the kathode inside the dark space showed the F line of hydrogen, and also the C line more faintly. These lines probably indicated the elimination of hydrogen from the electrodes, especially the kathode, as they became fainter with each repetition of the process of washing out.

At the sixth filling of the tube, the pump was worked for ten strokes only. The kathode then began to sputter and blacken the tube, and the argon was apparently absorbed, as the discharge refused to pass in three minutes. Fresh argon was again admitted, the coil was left running, but *the pump was not worked at all*. The spectroscope this time showed only blue argon without any trace of hydrogen. The concave aluminium kathode sputtered violently and partly melted down. In less than two minutes the discharge refused to pass through the tube, which was then sealed off.

The coil used in these experiments was a very small one, which gave a two-inch spark with difficulty when running on a large 8-volt battery.

The next tube upon which we experimented was a double focus tube, containing two aluminium kathodes and a platinum antikathode. This was washed out with argon and exhausted eight times with the two-inch spark coil running all the time. The direction of the discharge was frequently reversed, but no trace of absorption could be observed. The argon lines always disappeared, and the hydrogen lines, especially F, became faintly visible inside the kathode, as the tube approached an X-ray vacuum. The tube at each exhaustion gave fairly bright X-rays, and showed no blackening or sputtering. The hydrogen lines showed more brightly close to the kathode than in the body of the tube, where the argon lines were most conspicuous. The hydrogen appeared in fact to be coming out of the metal. The glass walls of the tube were in a very dry state, as it had been previously heated and exhausted.

Finding that we could not get rid of the residual hydrogen with the coil, we had resort to the alternating current, which we had previously found very effective in tubes with double electrodes. It appears that the elimination of hydrogen takes place chiefly, if not entirely, at the kathode. With the first application of the alternating current, the hydrogen lines showed extremely bright. The tube was then exhausted. In fifty strokes, the discharge refused to pass. On refilling with argon to a pressure of one-tenth of a millimetre, the blue glow inside the dark space showed only argon and no hydrogen. The pump on this occasion was not worked at all, but the gas apparently was absorbed, and the discharge refused to pass in about three minutes. There was some sputtering of the electrodes and blackening of the tube, but the aluminium, though blistered, was not melted. The experiment was repeated twice with the same results. On reconnecting the tube to the two-inch spark coil, the same absorption was observable but less rapid. The electrodes were larger, and were less heated than in the case of the first tube.

We concluded from these and similar observations, of which the above may be taken as a sample: (1) that the hydrogen occluded in the kathode played the part of carrier of the discharge from the metal to the gas. (2) That if there were sufficient occluded hydrogen, there would be little or no sputtering of the aluminium. (3) That when no hydrogen was present, the discharge was conveyed from the kathode by particles of the metal itself, which were capable of exciting fluorescence of the glass, and of gener-

[1] By Prof. H. L. Callendar, F.R.S., and Mr. N. N. Evans, Lecturer in Chemistry, McGill University, Montreal. (Read before Section A of the British Association, at Toronto.)

ating X-rays wherever they impinged, behaving in fact as kathode rays. (4) That in X-ray tubes, as usually exhausted, without excessive precautions for the drying of the gases, and the complete removal of residual hydrogen from the electrodes, the residual gas was in most cases hydrogen or water vapour.

In order to test the behaviour of other gases as compared with argon, similar experiments, in the same tubes, were made with dry air, with hydrogen, with oxygen, and with water vapour.

With dry oxygen and nitrogen, the absorption of the gas was very rapid at a pressure of one-tenth of a millimetre, if the electrodes were sufficiently heated. Although hydrogen was not observable and was presumably absent, the blackening of the tubes was very slight, and a much greater power could be applied than in the case of argon, without melting the electrodes.

With water vapour under the same conditions an X-ray vacuum could not be obtained (owing probably to the slowness of diffusion), unless the tube were considerably heated, either with a flame or by means of an excessive current. On allowing the tubes to cool under these circumstances, the vacuum improved very greatly, owing to absorption by the surface of the glass, and the discharge often refused to pass. Under steady conditions of running at a low temperature, there was no clear evidence of absorption of the water vapour, in spite of the drying tube on the pump.

With carefully dried hydrogen, under the same conditions, the process of exhausting the tubes with the mechanical pump was extremely rapid as compared with the other gases, owing to the greater velocity of diffusion of the lighter gas. With the smaller tubes, ten or twenty strokes were sufficient to give brilliant X-rays, starting in each case with a pressure of half a millimetre to a millimetre. There was no marked absorption at any stage of the vacuum, and no trace of sputtering of the electrodes. We expected to find some evidence of absorption by the electrodes or the platinum antikathode, but it is possible that these became saturated with gas very rapidly at an early stage, and ceased to absorb gas at an X-ray vacuum. We concluded that hydrogen was the most suitable gas to use in X-ray tubes, but it is possible that helium, being also a very light gas, might be equally good, if its inert or monatomic character does not lead to the disintegration of the electrodes in the same manner as in the case of argon.

If the great resistance to the passage of the discharge from the kathode to the gas in the case of argon, is dependent upon the monatomic nature of the gas, it might be expected that similar phenomena would be observed in the case of mercury. Some mercury vacuum tubes were therefore made in the form of inverted U tubes. The electrodes were liquid surfaces of mercury in each limb, to which connection was made by short pieces of platinum wire, which did not project above the surface of the mercury. These tubes were exhausted and boiled with an alternating discharge passing, until more than half the mercury had distilled over. They then presumably contained only mercury vapour. When cool, the two-inch spark discharge refused to pass at first, but if the tube were tilted for a moment, so as to expose the platinum wire, it appeared that sufficient gas was liberated to enable the discharge to pass without any difficulty. The tubes showed only the mercury spectrum. In the high resistance state, immediately after boiling, the kathode limb, with a larger spark coil, showed brilliant fluorescence and feeble X-rays. We concluded from these experiments that a very small trace of another gas was sufficient enormously to reduce the resistance of a mercury vapour tube, and that if the vapour could be obtained quite pure, it would possibly not conduct at all.

To verify more accurately the conditions of vacuum at which these phenomena occurred, the whole apparatus was subsequently connected to an automatic Sprengel mercury pump to which a McLeod gauge was attached. The pump and all its connections were carefully tested for leakage, and the drying tube was filled with fresh P_2O_5. We had found in previous experiments of a similar character made two or three years previously, that sulphuric acid, however carefully prepared, gave off appreciable quantities of water vapour, which would have been quite sufficient to vitiate these results.

Using a large coil and a slow mercury break, to avoid overheating the tubes, we found that fairly efficient X-rays were obtained in most of the tubes at an average vacuum of ·006 millimetre, if the tubes were exhausted in the ordinary way without taking special pains to remove the hydrogen. The H lines always showed faintly in the kathode light before this vacuum was reached. After using an alternating discharge to heat the electrodes, and carefully washing out the hydrogen as far as possible with argon, we found that the pressure corresponding to an X-ray vacuum gradually increased up to ·030 millimetre. Before letting the argon into the tube it was allowed to remain ten or fifteen minutes in contact with the fresh P_2O_5. On omitting this precaution and admitting the argon direct from a bulb containing an old sample of P_2O_5, which was beginning to deliquesce on the surface, it was necessary to raise the vacuum to ·015 millimetre before X-rays were produced. On the other hand, the sudden addition of dry argon at this stage up to a pressure of ·029, produced no change in the appearance of the tube. It is probable that we never succeeded *entirely* in eliminating the residual hydrogen, but we concluded from these and similar experiments that the presence of the argon by itself had little, if any, effect on the production of X-rays, since the amount present in the tube could be varied within wide limits.

We next endeavoured to ascertain at what degree of vacuum the apparent absorption of the argon previously observed could be reproduced. For this purpose we used two tubes of the double-focus pattern, and an alternating discharge. Taking the first tube slightly damp from the blowpipe, we exhausted it to one-fifth millimetre vacuum with the mechanical pump. The discharge was then turned on and adjusted to heat the tube and electrodes as much as possible with safety, *and the pump was not further worked*. Under these conditions the remaining water vapour was rapidly expelled and absorbed by the P_2O_5, the tube soon showed a brilliant hydrogen spectrum followed by green fluorescence, the antikathode became red hot, then cooled, and in fifteen minutes the discharge (20,000 volts) refused to pass. The tube was not appreciably blackened. On connecting to the direct current discharge, it gave brilliant X-rays. This case is interesting as showing that a very good vacuum may be obtained in these cases by simple absorption.

Dry argon was then admitted into the tube up to a pressure of 0·160 millimetre. At this pressure, in tubes three inches in diameter, with the direct or alternating current, the tube was filled with blue light, and gave a spectrum which was verified to be that of blue argon, without any visible trace of hydrogen or nitrogen. After running the direct and alternating current through the tube for half an hour, the tube became very black, but there was no change in the pressure as measured by the gauge. It should be remarked that in measuring these high vacua, the pump was usually stopped to allow time for the equalisation of the pressure throughout the apparatus. The alternating current in the primary of the coil was only 2·5 amperes with argon, whereas 4 amperes had been used with air. The latter current, if used with argon, would have melted up the kathodes. Finding no absorption at this pressure, the pump was started to run very slowly, and the same alternating discharge was continued. The sputtering of the electrodes rapidly increased, and at a vacuum of about one-tenth of a millimetre, the upper electrode suddenly melted off. Another tube was then tried, but met with a similar fate at the same degree of vacuum. The failure was so sudden that it was difficult to control the current in time. If the argon is actually absorbed, it is clear that the phenomenon depends upon very special conditions of temperature and discharge. It is possibly that the absorption is only apparent, and corresponds to a very sudden increase of resistance to the discharge at a particular degree of vacuum, such as occurs in an ordinary X-ray tube when the boundary of the dark space reaches the antikathode. With greater care, it may be possible to decide this point, but an unfortunate accident to our water mains prevented further investigations at the time. It is clear, however, that the behaviour of argon is peculiar, and it seems probable that most of the ordinary kathode ray phenomena are due to residual hydrogen.

THE ORIGIN OF THE EUROPEAN FAUNA.[1]

I HAVE endeavoured to show how the present fauna of Europe originated. For that purpose it was found advisable to commence the inquiry by the study of the past and present fauna of an island. The British Islands, and in particular Ireland, seemed to me most suitable for that object.

[1] Summary of a paper by Dr. R. F. Scharf, read before the Royal Irish Academy. (Reprinted from the *Proceedings* of the Academy, 3 ser. vol. iv. No. 3, 1897.)

The fauna of Ireland as well as the flora is found to consist mainly of two elements, one of which came from the north and the other from the south. In the fauna of Great Britain the same two elements occur, but there is, in addition, a third—an eastern one—chiefly confined to the eastern counties. The southern element contains animals which came originally from south-western, and others which migrated to the British Islands from the South and Central Europe. The former are confined to the south-western counties of England and Ireland, whilst the latter are chiefly found in the south-west of England, Wales, Ireland, and the west of Scotland. The northern element chiefly occurs in Scotland, the north of England, and the north and west of Ireland.

Though it may be admitted that a small percentage of the British fauna reached the British Islands by occasional means of dispersal, the bulk of it migrated on land. A land-connection must therefore have existed formerly between Great Britain and Ireland, and the continent of Europe.

The late Edward Forbes believed that the Lusitanian or south-western element in the Irish flora (it was not known at the time that there was also a similar fauna) came to Ireland in Miocene times and survived the Glacial Period on a now sunken land which lay to the south-west of that island. Almost all other authorities are convinced that both flora and fauna were entirely exterminated in Ireland during the Pleistocene Epoch, and that what exists there now, migrated to it after the Glacial Period.

A short statement of the general conclusions arrived at with regard to the geographical changes in Europe during later Tertiary times, and the chief migrations of animals now follows, so as to facilitate the comprehension of the principal arguments advanced in favour of the view that there were two distinct invasions of northern species, and that the Irish fauna is altogether pre-Glacial.

To judge from the range of the south-western European plants and animals in Ireland, it is evident, as Forbes suggested, that they came long before the other southern species or the northern ones. Last of all came the eastern or Siberian migrants. These never reached Ireland, but as we have such abundant evidence of the time of their arrival in Europe, the history of their migration is of great importance, since it furnishes us with a clue to the date of earlier migrations.

We have geological evidence that a vast migration proceeded from Siberia, and entered Europe between the Caspian and the Ural Mountains. A large number of mammals came with this Siberian invasion, and no fewer than twenty-nine species reached England, ten of which still inhabit Great Britain. There is no evidence that any of them ever lived in Ireland.

I have endeavoured to ascertain the causes of that migration and its geological date. Both Tcherski and Brandt, the two highest authorities, are of opinion that the present Siberian fauna lived in the country already in pre-Glacial times, and that, with the addition of some now extinct forms, such as the mammoth, it flourished as far north as the New Siberian Islands. Since the advent of the Glacial Period, the fauna is supposed to have very gradually retreated from these high northern latitudes, which are now almost uninhabitable.

Against these views it has been urged that, to some extent, the mammalian bones and carcases found in the New Siberian Islands, rest on a solid layer of ice, and that as this ice was probably formed during the Glacial Period, the migrations must have taken place in post-Glacial times. This presupposes an extraordinary amelioration of climate in Siberia, the effects of which certainly would have been felt in Europe, but of which we have no evidence.

There is geological evidence that a marine transgression took place in Northern Russia in early Pleistocene times, and that at the same time the united waters of the Caspian Sea and the Sea of Aral covered a large tract of the central parts of that country. It is supposed by some naturalists (and in favour of this view I have collected some additional facts) that the White Sea and this large inland sea were connected right across Russia, thus forming a barrier by means of which the Siberian fauna was prevented from migrating to Europe. It is also suggested that the whole of the continental boulder-clay is a marine deposit, and that its maximum southward extension approximately marks the shores of a north European ocean.

In support of this view are quoted a number of Caspian species which must have come from the Arctic Ocean, and the fact of the occurrence of *Dreyssensia polymorpha*, in the lower and not in the upper continental boulder-clay, thus proving that a migration took place in both directions.

As all the deposits in continental Europe, containing remains of Siberian mammals, are of a later age than the lower boulder-clay, it seemed to me that the connection between the Aralo-Caspian and the White Sea must have ceased to exist during and after the Interglacial phase of the Glacial Period, which would also explain the absence of Dreyssensia in the more recent beds. The Siberian fauna probably began to pour into Europe immediately after the deposition of the lower continental boulder-clay. But since the first Siberian mammals made their appearance in England, during the deposition of the Forest-bed, the British newer Pliocene beds must be contemporaneous with this boulder-clay. Further proof of this will be mentioned later on.

Some further evidence is now given in favour of the marine origin of the boulder-clay, and the causes of the absence of marine shells in the Russian deposits are explained.

We have geological proofs that the Siberian fauna migrated to Europe on a tract of country known as the "Tchernosjen" or black earth of Russia, and that this originated from the decay of grass which grew there during long ages. This fauna then invaded Central Europe and Great Britain. In France its further progress was arrested by the river Garonne. England and France must therefore have been connected; whilst the absence of deposits containing Siberian mammals from Scandinavia proved that it was separated from the continent.

The Northern or Arctic element in the Irish fauna must have come directly from the north. It is more or less confined to the northern and western parts of Ireland, and forms a large proportion of the fauna of Scotland and Scandinavia. It suggests that a land-connection between the latter and the British Islands must have existed. The present and past range of the Arctic hare, the reindeer, and the stoat are discussed in detail to show that such a connection actually united the two countries. Reference is also made to the North American species occurring in Ireland which belong to the same migration.

The evidences in favour of a former land-connection between Scandinavia and Greenland *via* Spitsbergen are now reviewed.

It is suggested that the American marine mollusca which have been discovered in late Tertiary deposits of the east coast of England reached that coast, not from the Atlantic, but from the Arctic Ocean by means of the sea which extended from the White Sea to the German Ocean.

The migration of terrestrial animals and plants from this ancient northern land southward took place chiefly during the deposition of the newer English crags, and of the continental lower boulder-clay, that is to say, before the Siberian migrants set foot on British soil.

The southern migration to the British Islands commenced earlier than either the Arctic or the Siberian. Numerous instances are quoted to prove that the southern fauna is composed of species of south-western and of southern and Central European as well as of Asiatic origin.

In connection with the origin of the Red Deer, the nature of the geographical changes which the Mediterranean basin has undergone during later Tertiary times are now discussed.

I have endeavoured to show that Ireland was separated from England at the time while the migration from Southern and Central Europe was in progress. The contradictory evidence from fossil sources as to the climate prevailing at that time in the British Islands are there now discussed.

The orgin and nature of the Glacial Period is so intimately connected with these faunistic problems, that it has been thought advisable to devote a short chapter to this important era in the life of the direct ancestors of our animals. The prevailing opinions as to temperature and general atmospheric conditions during the period are reviewed in connection with the questions as to the possibility of a survival of the terrestrial fauna and flora chiefly in the British Islands. The British Pleistocene fauna does not indicate the prevalence of Arctic conditions—neither does the flora.

This fact certainly supports the view formerly held by geologists that the phenomena in Northern Europe, now attributed to land-ice, have been produced by sea with floating icebergs, under conditions somewhat comparable to those at present obtaining in Tierra del Fuego. A succinct statement of my views on the Glacial Period and the geographical features of Europe at the time—as derived from a study of the European fauna and of its origin—concludes this memoir.

MANCHESTER'S REPORT ON TECHNICAL EDUCATION IN GERMANY AND AUSTRIA.

IN pursuance of a resolution of the Technical Instruction Committee of Manchester, confirmed by the City Council, a deputation, comprising Alderman James Hoy, Alderman J. H. Crosfield, Councillor Nathaniel Bradley, Mr. Ivan Levinstein, Mr. John Craven, Mr. Charles Rowley, with Mr. J. H. Reynolds (Director), recently visited certain institutions and schools on the continent devoted mainly to scientific and artistic instruction as applied to industrial and commercial pursuits. The Report of the Committee has just been published, and the following extracts from it will do much to show the British public the extent to which provision is made in Germany and Austria for the supply of instruction of a scientific and technical character in aid of the commerce and of the industries of these countries.

Since 1891, when a deputation from the Technical Instruction Committee visited some of the continental countries, the Council has undertaken the task of maintaining the Technical and Art Schools of the city; and with the purpose of giving full effect to this responsibility, has already not only greatly developed these institutions, but has embarked upon the erection of the largest technical school in the country, the proper equipment of which is a matter of the most serious concern and importance. The erection of the new school was begun in August 1895, and its completion, ready for occupation, is confidently expected at an early date. The Committee, therefore, felt that it was high time the question of the equipment of the school was considered, especially in respect of the important departments concerned with the textile industries, with the industrial applications of chemistry, and of physics in relation to electrical engineering.

The extraordinary development which has taken place within quite recent years in electrical science as applied to electrical engineering industries, and the certainty of great extension in the near future, make the equipment of a large technical school a responsible matter.

Hardly less important than electricity is the great textile industry in its various departments of spinning, weaving, designing, dyeing, and finishing, in some of which we find ourselves at a serious disadvantage (especially those in which chemistry plays a part) as compared with our foreign competitors.

It has been found necessary in the dyeing and finishing schools abroad to discard mere laboratory methods, and to equip them on a scale approaching that of the works themselves, and analogous to the practice obtaining in the spinning and weaving schools, so as to give the students who are trained in them a real, practical, and effective knowledge of the processes employed.

The Crefeld Dyeing School.

Hence at Crefeld, where the Textile School already enjoys a world-wide repute for the splendour of its equipment, and the effectiveness of its influence in promoting the special industry for which Crefeld is famous, and which finds in this country its best market, the Prussian Government have built and equipped a large three-story building in the near neighbourhood of the present Textile School and Museum as a Dyeing and Finishing School. This School contains extensive chemical laboratories for instruction in qualitative and quantitative analysis, physical laboratories, drawing-rooms, lecture and testing rooms, chemical museum, reading-room and library. In the library are to be found technical books of all nations bearing upon textiles, all of which are introductory to the special work of the school, namely, the dyeing and finishing of textile goods, particularly those of importance to the special industries of Crefeld and the district.

Much attention is given to the examination of colouring matters, and to mordanting on all kinds of fibres and cloth; and constant experimenting, with a view to new materials and processes, is a special feature of the instruction. Experiments are undertaken in testing the colours employed, and in dyeing the yarns for exposure to light, adverse atmospheric influences, resistance to acids, alkalis and soaps; and investigations are made with a view to the production of colouring matters formerly employed in the dyeing of old tapestries. Every effort is made to assist the manufacturers and merchants; and on their behalf the school will undertake investigations as to the dyeing and finishing of materials submitted, which, when completed, are reported to the manufacturer or merchant, with information as to the methods used, and the chemicals employed on the fabric, together with the cost of production. These investigations are carried on by the students under the direction of the teachers, and are of inestimable value to them as a training in solving real industrial problems.

The Crefeld School as an Example to be Followed.

Your deputation is convinced, as a result of the inspection of the Crefeld School, that the Manchester district would gain materially by the development of the Textile School in the new building on the same lines.

(1) By the increase in the number and variety of the looms and of the goods woven upon them.

(2) By the establishment of a school of tinctorial chemistry, and of practical dyeing and finishing, upon an adequate scale, alike in respect of the completeness and the real efficiency of the machinery employed.

(3) By the establishment, in actual touch with the other departments of the school, of a well-organised museum, replete with examples of ancient, mediæval, and modern productions of the best type of workmanship, colour, and design.

It is to variety and excellence in these respects that Lancashire must look to maintain and increase its supremacy and reputation as a manufacturing centre.

How Prussia Disseminates Technical Information.

As showing the thoroughness and the zeal with which the Government supplies the means of technical training in the various industries of the country, it was stated to the deputation that if any paper—dealing, for example, with some department or detail of the textile industry—is read before any foreign society, and is published, or appears in any journal, the communication is immediately translated and circulated throughout the textile schools of Prussia, with directions to have it dealt with as a lecture to the students; and if models, illustrations, or lantern slides are required by way of illustration, they are prepared and sent with the paper. Moreover, in Berlin there exists a department of the Bureau of Education not accessible to visitors or inquirers, where models, diagrams, and other means of illustration are prepared and circulated to the technical schools of the country.

The Efficiency and High Standard of Technical Instruction in Germany.

Your deputation are convinced that the textile schools of Germany, so far as they have observed them, are of singular value in training up a supply of exceedingly well-instructed men, capable, by reason of the methods employed, the examples studied, the variety of the appliances used, and the investigations and experiments made, to take the lead as foremen, managers and manufacturers in the industries concerned.

The present and potential importance of the electrical engineering industry led your deputation to visit Darmstadt, where, in 1895, the Technical High School was entirely rebuilt on a greatly enlarged site at a cost of 130,000*l.* The school includes, in addition to the main building, and opposite to it, two fine buildings—one for physics and technical electricity, and the other for pure chemistry, electro-chemistry, chemical technology, and pharmacy.

It is important to remember that these figures referring to the cost of building represent a much larger corresponding cost in England—for example, the cost of the Darmstadt building, which is of stone, was only 5*d.* per cubic foot, which is about half the cost of similar buildings in England. This remark applies also to statements of cost of administration and of teaching—salaries being on a lower scale than with us. It is, however, important to observe that the principal professors enjoy the status and the advantages of civil servants.

It is to be noted that Darmstadt has only 57,000 inhabitants, and that the entire State, of which it is the chief city, has a population of not more than one million. This Technical High School is an institution of university rank, and is built on a scale of great liberality. Considerable as it is, it was felt by the authorities that the growing demands and development connected with electrical science and its adaptation to industrial needs and the general service of the community necessitated the establishment of special provision in suitably equipped buildings of means of instruction in electro-chemistry and electrical engineering. This has been done, as already stated, in two new and separate buildings (which are even now being enlarged), on an excep-

tionally complete scale. The efficiency, extent, completeness, and fine organisation of the equipment in the electrical building especially impressed the deputation.

Darmstadt undoubtedly possesses the means of giving the highest possible theoretical and practical instruction to electrical engineering and electro-chemical students, and that this is highly appreciated is shown by the fact that out of the 1100 day students in attendance in this school (all of whom are over eighteen years of age), more than a third of them are enrolled in the physics and electrical engineering division. The reputation and efficiency of the school attract a large number of students from various European countries.

The equipment of this school has set before the deputation an excellent example of the methods to be followed in equipping the electrical engineering and physical department of the new Technical School of this city, though we may not hope that it can be approached either in extent or completeness, for want of space and want of means. The cost of this department alone has been 28,000*l.*; and the building, which is three stories in height, stands upon a space of ground 123 feet by 140 feet.

The comparatively advanced age of the day students in German technical schools is especially remarkable as showing (1) the relative position of technical schools with respect to general education on the continent and in England; (2) the standard of attainment reached before entering upon specialised studies; and, lastly, as indicating the advance which is possible under such circumstances.

ADVANTAGES OF SCIENTIFIC AND TECHNICAL TRAINING.

Without doubt the general industry of the country gains immensely by the extended time given to scientific technical training in the supply of a large number of adequately educated men. Nothing is more striking than the prevision of those responsible for the education of the German and Swiss people in providing the means for the best possible training in chemical science and its industrial applications.

The sense of the importance of chemistry as a predominant factor in future industrial developments, led to the establishment of large and costly laboratories, directed by the most eminent men of science of the day, where students were encouraged to devote five, six, or even seven years to study, with the result that it has unquestionably placed the German and Swiss manufacturers, especially the former, easily first as the greatest producers in the world of colours and fine chemicals.

The success of this policy may be realised from the fact that the great colour manufacturing works of the Badische Anilin and Soda Fabrik at Ludwigshafen, on the Rhine, alone employs nearly 5000 men and upwards of 100 scientifically trained chemists, its technical laboratories themselves being on the scale of the laboratories of a great university. In 1865 this firm employed only thirty workpeople. These works are but one of several on a similarly large scale.

The command of the world's market in colouring matters and pharmaceutical products derived from coal-tar, the value of which is estimated at about 10,000,000*l.* sterling, is in the hands of Germany to the extent of three-fourths, 75 per cent. of which is sent abroad.

The success in this great department of applied science has stimulated the educational and industrial leaders of Germany to further efforts, and the recent great advance in knowledge in the department of physical science has resulted in the erection and equipment of electrical laboratories on an imposing scale at Stuttgart at a cost of 100,000*l.* (including additional provision for the study of pure chemistry), at Hanover, where a new Electro-Technical School has been added to the Royal Technical High School, and again, as already stated, at Darmstadt.

It is clear that the educational advisers of the various German Governments are of opinion that the same success which has already attended the establishment of numerous and costly chemical laboratories in stimulating German industry, and placing the nation first in the manufacture of chemical colour products, will be repeated through the establishment of like laboratories for the study of technical electricity as applied to the field of chemistry and to engineering.

The real bearing of the importance of electricity in association with chemistry in the production of new organic and inorganic compounds, and by electrolytic action of the more economical production of chlorine and of such metals as zinc, nickel, sodium, potassium, and aluminium, is hardly fully grasped in this country, so far as means exist for its study; but there is abundant evidence of the activity af Germany in the establishment of special schools and laboratories, splendidly equipped, with a view to important industrial developments in the near future, which will win for Germany a similar pre-eminence to that she has attained in the domain of chemistry.

PROGRESS IN GERMANY.

That Germany is in a prosperous condition, due to her successful manufacturing and commercial enterprise, was plainly evident on every hand in the extension of her cities—the making of new streets, and the erection of fine, handsome buildings which is going on everywhere in her large towns.

It is not less clear that the schools are the root and base of this surprising industrial development, and are the main contributors to this great economic result; it is no less certain that if we are to maintain our position as a great industrial community, it must be by following and adopting the same methods.

It is not, however, only in the domain of science that Germany is making great progress. In almost every town visited by the deputation fine industrial art museums were found, arranged with the express purpose of cultivating a knowledge of what has already been accomplished in the production of fine examples of colour, design, and workmanship. Every technical school has its special museum of objects applicable to its purposes. Notably was this the case in Berlin, Vienna, Nuremberg, Crefeld, and at Düsseldorf, in which latter place the Industrial Art Museum is said to be the finest in the Rhine land. These museums help to preserve and hand down the traditions of past achievement and excellence, and stimulate the desire to reach to as high, or higher, levels to-day.

INFLUENCE OF TECHNICAL SCHOOLS ON INDUSTRY.

In submitting this report, your deputation are not insensible to the consideration that it may be thought that a too favourable view has been taken of the educational provision and the industrial advance observed by them in German States as compared with the position in England.

In deprecation of such possible criticism, they would observe that it is by no means a difficult matter to trace to the influence of the schools, and the system of education generally, the improvement which has marked the manufacturing progress of Germany and especially the unique position occupied by the chemical industries in that country.

Almost every industry has schools specially equipped and staffed—well described by the phrase Mono-technic Schools. Such schools are almost unknown here, or are to be found in connection with only one or two industries, as, for example, with weaving and dyeing, and one or two other industries, such as tanning; but even in these cases the number is very limited, and the day students are comparatively few, whilst the equipment is nowhere on the ample scale of Crefeld.

The German Mono-technic School is intended primarily for day students, and only incidentally for evening students. The knowledge, skill, and experience of the highly-qualified staffs are all directed to the advantage and cultivation of the day students, and your deputation are of the opinion that that policy must be followed here if any marked industrial advance is to be secured.

The attention of the deputation was frequently directed to the importance of another factor in the development of German commercial progress, namely, the careful attention given to the study of foreign languages, especially to English (which latter language is most successfully taught), with a view to their use in business transactions, and of enabling those engaged in commerce to come into the closest relations with customers in all parts of the world.

It is further desirable to draw attention to the advantages enjoyed by foreign nations by the adoption of the metric system. The ease with which the knowledge and use of it is acquired, and its universal adoption, in all scientific training and investigation, not to speak of its value in commercial transactions in foreign markets where, with rare exceptions, it is employed, make its universal adoption here much to be desired.

The excellent system of secondary education has greatly contributed to this, but, in addition, special commercial schools are found in all the largest towns.

LESSONS TAUGHT BY GERMANY.

Referring once more to Germany and especially to Prussia, your deputation cannot conceal their sense of the advantage, whatever may be the ultimate drawbacks, of a centralised

bureaucratic administration which, taking a careful survey of the educational and industrial needs, places the schools here or there as circumstances require, brings them into mutual relation, supplies ample means, and effectively assists without loss of time the industrial advance. Something may be lost of "freedom, variety, and elasticity," and that loss may ultimately be serious in its effect upon individual initiative, upon which we as a nation so confidently rely. Which is the better policy the future can alone determine. It may, however, be safely asserted, that it is high time the effort was made in this country to give to our youth the educational advantages, general and special, which are enjoyed by their rivals abroad.

Exception has sometimes been taken to the size and cost of the new building now being erected by the Technical Instruction Committee for the Municipal Technical School, but your deputation have returned from their visit doubly confirmed in their conviction that every foot of space will be needed, and that even when fully utilised and equipped it will fail to rival in amplitude of resource the splendid industrial schools of Germany and Switzerland.

The report, of which the above is a summary, was presented to the Manchester City Council on Wednesday, October 20, when the following interesting discussion, abridged from the *Manchester Guardian*, took place upon it:—

Mr. Alderman Hoy, Chairman of the Technical Instruction Committee, moved the adoption of the report. The report, he said, contained the latest information as to the developments of technical instruction upon the continent, in the countries named, in respect of certain specific industries, more especially textile manufactures, dyeing and finishing, and electrical engineering, and, generally, what was being done in these countries under the name of technical education. It was to this point, and to this alone, that he wished to draw the Council's attention. The term "technical education," as generally used in this country, was much abused. It would appear to mean anything, as occasion might require, from an evening continuation school for teaching the elements of cookery or the practice of sewing and cutting-out, up to an institution designed to give the highest form of specialised scientific instruction. No doubt the grant of funds from the Exchequer, under the provisions of the Technical Instruction Act, and the vague and general definition of the objects of the Act, contributed to this loose interpretation of the phrase and to the application of the money in aid of almost every form of instruction. Let him give the definition of the phrase as understood in the Manchester Municipal Technical School:—"The chief object of the Technical School is to provide instruction in the principles of those sciences which bear directly or indirectly upon our trades and industries, and to show by experiment how these principles may be applied to their advancement." This object was carried out in two ways—first, by day instruction; second, by evening instruction. As with the country generally, evening teaching was at present by far the most important in point of the numbers taught and range of subjects, the numbers in the daytime being only the merest fraction of those in attendance at night. The object of the evening student was to supplement the practice of his daily occupation by an attempt to study and to understand the scientific principles which underlie it, in the hope of increasing his efficiency as a workman. Without doubt this was a most desirable object, and the schools which provided such instruction and those who took advantage of it, often under conditions requiring the greatest sacrifice of time and strength, deserved the highest praise. Nevertheless, important and valuable as was the provision made in this country for evening scientific and technical instruction, and useful as it undoubtedly was to the artisans who with scant educational equipment endeavoured to profit by it, it could not, when regarded from the wider view of the serious industrial and commercial competition among the leading nations of the world, be accepted as satisfactory or as sufficient to enable this country to maintain its position, especially in those industries where scientific knowledge and training were indispensable factors. Thus the efforts of the chief continental nations were directed to the highest scientific training of those who were ultimately to become the leaders and organisers of the great scientific industries. The main point of interest in the report now presented would be found, therefore, to lie in the emphasis (only faintly indicative of the real extent and wealth of equipment and teaching power which was observed) laid upon the abundance of the provision for scientific instruction to day students preparing to enter upon industrial pursuits, and its quite extraordinary development within the past few years. In every industrial centre new buildings were rising, old institutions were being enlarged, and their equipment increased in order to keep pace with the demand for better and more advanced training in science and art, with a view to industrial and commercial advancement. The advance in scientific knowledge of the past half-century had changed the conditions of the industrial problem, and had gone far to equalise the struggle for industrial supremacy, or at least was tending to make countries once dependent upon us for supplies of manufactured goods more self-contained and self-supporting, and even to enable them to meet us in open markets. It was a case of steam dependent upon abundant coal supplies *versus* electricity dependent upon abundant water power. Germany had already found her reward in her command of the market for products requiring the aid of the highest scientific skill in chemistry, due entirely to the existence of her schools, and what she had done in the domain of chemistry she hoped confidently she would do in that of electricity also. The future of the manufacturing industry depended entirely upon the application of the highest scientific skill and experience in developing natural resources and products, and those nations which realised the truth of this and provided for the training of the leaders and organisers of industry would surely win the day. Nothing struck the English visitor to Germany more than the extraordinarily large number of well-educated young men in the day departments of foreign technical schools, clearly pointing to the recognition of the value of scientific training as the chief element and necessity for industrial efficiency and success. The report now presented was not written with any idea of depreciating the value or skill and efficiency of the English workman, but with the aim of showing how much more efficient would be the result of his efforts if directed by leaders and managers who were themselves thoroughly trained in the principles of science and of art in their application to the industries in which they were engaged. Without doubt we had the finest race of workmen in the world. Their fine qualities would be improved by education, and their opportunities of advancing to the front rank of leaders and managers in our great and varied industries would be well served by the facilities now increasing on every hand in every industrial centre of the country through the operations of the Technical Instruction Act, and he, as one of their sincere well-wishers, trusted that they would take full advantage of the facilities thus freely offered.

Mr. Alderman Crosfield, deputy-chairman of the Technical Instruction Committee, in seconding the motion, mentioned that the deputation was accompanied by Mr. Charles Rowley and by Mr. Reynolds, director of technical education, both of whom showed great interest and enthusiasm in the subject. The deputation found that since the deputation from the Corporation, headed by Mr. Alderman Rawson, went to the continent some years ago very great progress had been made, particularly in Germany. The paternal Government of Germany and the good sound sense of the German people had put that country far ahead of us in educational matters. The difference between the German artisan and the Lancashire artisan was very great, and if we did not take care we should be not only as far behind that country as we were at present, but a great deal further. The idea that students should go to the technical schools unprepared, which was a thing we suffered from very much here, was apparently entirely unknown in Germany. It was much to be regretted that in this country parents, preferring a few shillings now to pounds a few years hence, should take their children away from the day schools at such an early age.

Mr. N. Bradley, who also accompanied the deputation, said he was struck with the complete way in which the work was done in the technical schools in Germany. Every penny that could be spent in Manchester for the purpose of technical instruction would be to the advantage of Manchester and of the people of this country. The impression that entered his mind was that in all industrial pursuits where there was competition it was a great advantage to see the other side. Consequent on the kindness of the professors and the officials connected with the continental institutions which they visited, everything was shown to them, and the benefits of experience were placed unreservedly at their disposal. They found that the schools were conducted under a system in which cleanliness and discipline showed themselves on every side. The result of the teaching the pupils received was exemplified in this country, for it was a fact that foreigners came to England to fill places which ought

to be held by Englishmen. He believed it would be possible to save a very large sum of money to the ratepayers if the equipment of our technical schools were made far more efficient than they had been.

Sir Bosdin Leech supported the resolution. They had, he said, just heard what was being done on the continent. He had recently crossed the Atlantic and travelled in America and Canada, and he found that there the course of education was being greatly pushed forward. He saw what was being done there in the way of the introduction of labour-saving appliances, and in the efforts that were being made to oust us from the markets of the world, and unless we went forward much more quickly than we had done up to now, improving the minds of our children and increasing our scientific teaching, we should be distanced very materially. Already we were far behind the United States and Canada in the matter of electricity. In thirty or forty towns which he visited he did not see a single horse employed in traction. Electricity was used, and people were able to get about very rapidly. Electricity was also applied to the lighting of streets in a way that was most effective. He felt that we should strain every nerve to help forward the work of the Technical Instruction Committee.

Mr. Alderman Higginbottom said he had had an opportunity of seeing on the continent what Sir B. Leech had seen in America The subject of electricity had occupied a great deal of the attention of the Technical Instruction Committee, and he wanted to emphasise very strongly that it was the duty of that committee to place every convenience before their students who were studying electricity. He regretted that he and those who accompanied him were forced to the conclusion that England was very much behind continental nations in regard to electrical work. Sir Bosdin Leech had said that electric traction was everywhere adopted in America. It was also almost universal on the continent. But besides electricity, we had something else to learn. We had been under the belief that we were the home of engineering, but we were nothing of the kind. He had travelled through the principal cities of France, Germany, Austria and Italy, and had visited fifty of the finest electric stations for traction and lighting purposes, and, with one exception, he found that all the machinery used in those stations was from the works of continental firms. The deputation had seen engines of 1000 and 1500 horse-power, vertical and triple-expansion engines—which we thought we could build in Lancashire better than anybody else—and he was bound to say that he had never seen finer. The whole secret of the success of the foreign engineer was that for many years the foreigner had been giving his students the best technical instruction possible. He said nothing about the capabilities of the German workman as compared with those of the English workman. The English workmen were superior to the German or Italian workmen in the matter of ordinary work, but as regarded technical training and in matters of detail they were far ahead of us. The workshops were kept in the cleanest and most systematic way, and they were able to turn out work cheaper than it could be done in England.

Mr. Alderman Rawson said the matter under discussion was not merely of local, but of national importance, and attention to it was requisite if we were to maintain the position we had hitherto held. Since the establishment of the textile department of the Technical School in 1882, the Committee had been dependent upon the foreigner in every case but one for the teaching of dyeing, bleaching, and printing, and they had paid higher salaries in that department than in any other, with one exception. The foreigner had anticipated us not only in technical matters, but in the preparation of men who were competent to teach in those subjects. He hoped the report of the Committee would be widely circulated and read. With regard to our general system of education, he hoped the time was not far distant when the clever child of the poor man would be able to proceed from the elementary school to the Grammar School, the Technical School, Owens College, and the University.

Mr. Trevor said he hoped the effect of the speeches that had been made would be to induce public men to pay more attention to the subject under discussion; then they would perhaps not feel called upon to subscribe so much in the way of amusement, and give rather more to matters of real profit. At the Owens College he understood they had an important section for giving instruction in steam-engine testing. The subject of steam-engine testing and the taking of diagrams was a most important one; yet last week the number of students from this great centre of engineering, with its half-million of inhabitants, was only five, and the teacher told the students that unless they could make the number up to seven it would not be worth while to carry on the class. The fees, he understood, were only two guineas for a term of ten lessons. We possessed as much conceit as any country on the globe—he meant the thing that stood in the place of ability; it was very common—but we could only produce five young men interested in their work to the degree that they wished to perfect themselves in it. We were always talking about our being the best workmen in the world. Those who worked were the best, but men should do a little more for the honour of their work, and, apart from the question of wages, try to perfect themselves in it. It was time the British workman should try to improve himself individually, and not depend so much upon organisation. If he would take more advantage of the expensive arrangements that were provided for him, and study, we should get back our trade.

Mr. J. Phythian (Gorton) said that as a member of the Amalgamated Society of Engineers he went upon the deputation with a prejudiced mind. He believed the working men of England were capable of building engines and dynamos superior to any, but his opinion had been changed. He saw work done by continental artisans—and he thought he was a fair judge of good work—which would put to shame a great deal of the work done in this country. He was perfectly certain he never saw better engines built than those which he saw being constructed on the continent. He attributed this to the care with which the workmen were trained in details, which enabled them to excel in those niceties which were absolutely essential in the making of engines and boilers.

Mr. Mainwaring said as a member of the deputation he was glad some plain unvarnished truths had been uttered in that chamber. Twenty years ago he visited some of the towns visited by the deputation, and he was amazed at the great advances which had since been made. It was quite time the veil was torn from the eyes of the English workman, and that we abandoned the short-sighted belief that no one could touch us in our various industries. The deputation had not come in contact with a single foreman of works in Germany who could not speak to people in either French or English. He should like to know where they would find a foreman in works at home who would be able to speak to a visitor in German or French. They found that these foreign foremen could speak to them as easily in English or French as in their native language.

Mr. Wilson said he had seen engine work in America and Canada, and he had recently travelled on the continent, but he had seen nothing which, to his mind, was superior to English workmanship. He had heard it stated repeatedly that German workmen were not superior to English workmen when they came to work with the vice, and he believed that was an understood thing. He should strongly oppose the introduction of any foreign machinery into Manchester in connection with the extension of the use of electricity.

The resolution was adopted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Sir W. L. Buller, F.R.S., has presented to the University a valuable skeleton of the Elephant Seal for the Museum of Zoology.

Dr. Hobson, F.R.S., Dr. Bryan, F.R.S., Mr. A. N. Whitehead, and Mr. A. Berry have been appointed examiners for Part ii. of the Mathematical Tripos.

The examiners for the Natural Sciences Tripos 1898 are: in Physics, Mr. Shaw, F.R.S., and Mr J. T. Bottomley, F.R.S.; in Chemistry, Mr. A. Scott and Dr. W. H. Perkin, F.R S.; in Mineralogy, Mr. A. Hutchinson and Mr. L. Fletcher, F.R.S.; in Geology, Mr. Teall, F.R.S., and Mr. Marr, F.R.S.; in Botany, Dr. Marshall Ward, F.R.S., and Prof. R. W. Phillips; in Zoology, Mr. Shipley and Mr. Jeffrey Bell, F.R.S.; in Anatomy, Dr. Barclay Smith and Prof. A. M. Paterson; in Physiology, Dr. Shore and Dr. Waller, F.R.S.

The examiners for the Mechanical Sciences Tripos 1898 are Prof. Ewing, F.R.S., Prof. Perry, F.R.S., and Mr. Peace.

Mr. Marr and Prof. Judd have been appointed examiners for the Sedgwick Prize in Geology.

The Rev. Prof. Wiltshire has given his extensive and valuable collection of minerals to the Mineralogical Museum. It contains a large number of beautiful and costly specimens.

At the matriculation on October 21, 872 freshmen, including nine advanced students who had graduated in other Universities, were enrolled.

The Harkness Geological Scholarship for women has been awarded to Miss Hilda D. Sharpe, of Newnham College.

THE first Congregation of the *Prifysgol Cymru* (University of Wales) for conferring degrees was held in the Park Hall, Cardiff, on Friday, October 22. Ten students from Aberyst-wyth, Bangor, and Cardiff were admitted to the B.A. degree of the University, and five, including one lady, to the B.Sc. degree.

THE new physical laboratory and workshop at the Langton Schools, Canterbury, were formally opened on Tuesday under the presidency of the Ven. Archdeacon of Maidstone. Dean Farrar gave an address in which he traced the growth of scientific instruction in secondary schools, and emphasised the work done by the Committee of the British Association in developing the newer methods. The new rooms give the school full facilities for instruction in science, as it now comprises chemical and physical laboratories, store-room, manual workshop, and a well-equipped lecture theatre devised somewhat after the plan of the chemical lecture theatre at the Royal College of Science.

SCIENTIFIC SERIALS.

American Journal of Science, October.—Fractional crystallisation of rocks, by G. F. Becker. Among the phenomena most often appealed to in support of the theory of magmatic segregation or differentiation is the symmetrical arrangement of material in certain dikes and laccolites. But this separation is more readily accounted for by the theory of fractional crystallisation. Before solidification, the lava constituting a dike or laccolite is subject to convection currents. The colder masses flowing down the sides of the bed deposit first the less fusible rock, leaving the more easily fusible mass to solidify in the centre. The process only takes weeks where a molecular flow would take centuries.—On the conditions required for attaining maximum accuracy in the determination of specific heat by the method of mixtures, by F. L. O. Wadsworth. Errors in reading temperatures are the most serious. To avoid them, the calorimeter should be small, and the surface of the solid large. The initial temperature of the latter should be as high as possible. The calorimeter should be surrounded by a water jacket, maintained at a temperature higher than the initial temperature of the water by an amount given in an equation worked out by the author. He also describes an improved calorimeter in which the body is conveyed in a small car of sheet copper along a track laid along an inclined tube which serves as a heating chamber. This prevents loss of heat, and also enables the observer to experiment upon small fragments.—On a new species of the Palinurid genus Linuparus found in the Upper Cretaceous of Dakota, by A. E. Ortmann. Two unique specimens of a hitherto unknown fossil have been acquired by Princeton University. They are the first remains of the Palinuridæ found on the American continent. They not only show all the chief characteristics of the family, but are so well preserved that their generic position may be made out. The fossil is congeneric with a species living now-a-days in the Japanese seas, namely with *Linuparus trigonus*, hitherto regarded as a monotypic genus. The author calls the new species *Linuparus atavus*, and gives a full description.—On an improved heliostat invented by Alfred M. Mayer, by A. G. Mayer. The author describes a form of heliostat invented by his father, which is of simple construction and possesses certain decided advantages. It consists of a kind of wide telescope containing a large object-glass and a bi-concave lens which concentrate a parallel beam upon a system of two total-reflection prisms, one of which is mounted on the axis of rotation. A very intense beam is thus obtained, which is at the same time so free from heat that the most delicate microscopic slides may be exposed to the rays. Magnifications of 3800 diameters may thus be obtained on a screen.

American Journal of Mathematics, vol. xix., No. 4 (October).—On three septic surfaces, by J. E. Hill. The surfaces here discussed at some length are thus introduced: If, in the general cubo-cubic transformation between two spaces, we cause the principal sextic of one space to degenerate into a twisted quintic of deficiency 2, and into a right line meeting the quintic twice, to the general cubic surface upon which the right line lies, there will correspond in the second space, a septic surface upon which the line is triple and the quintic is double. If, however, the principal sextic of the first space breaks up into a twisted quartic of the second kind, and into a conic, meeting the quartic four times, to the general cubic surface passed through the conic, there will correspond in the second space, a septic surface possessing the quartic doubly and the conic triply. If, however, finally, the principal sextic of the first space degenerates completely, to the general cubic, passed through two transversals, and one line, of the remaining ingredients (four lines), there will correspond, in the second space, a septic surface, possessing three lines (corresponding to the first three above) triply and three lines (corresponding to the last three) doubly.—On Sylvester's proof of the reality of the Roots of Lagrange's Determinantal Equation is an examination by Dr. Muir of the applicability of Sylvester's proof (*Phil. Mag.*, 1852) to an extension of the theorem which recently appeared in the *Phil. Mag.* Dr. Muir gets some interesting results.—Dr. Kluyver, of Leyden, writes concerning the twisted biquadratic.—M. René de Saussure, in "Calcul Géométrique Réglé," gives an analytical treatment of a subject which he had previousl discussed, by a purely geometrical method (see his article " tude de Géométrie Cinématique réglée," vol. xviii. No. 4).—In a note on Mr. A. B. Basset's paper, "Theory of the Action of Magnetism on Light" (vol. xix. p. 60), Dr. Larmor offers a few remarks which he hopes may be worth recording.—M. Paul Appell gives a few examples d'inversion d'intégrales doubles "que j'ai énoncé dans une courte Note des *Comptes rendus*, Fév. 1, 1897." Two Notelets are: Bemerkungen zu C. S. Pierce Quincuncial Projection, by I. Frischauf, and on the Sign of a Determinant's Term, by Ellery W. Davis.

Bulletin of the American Mathematical Society, October, vol. iv. No. 1.—The number opens with an account of the fourth summer meeting of the Society, which was held at Toronto on August 16-17 of the present year. Owing to the meeting of the British Association, and from other causes, the success of the gathering exceeded all anticipation. Fifty-five persons attended, and twenty-one papers were read. An analysis of the papers is given, and two of them are printed *in extenso*—concerning regular triple systems, by Prof. E. H. Moore, and collineations in a plane with invariant quadric or cubic curves, by Prof. H. S. White.—"A generating function for the number of permutations with an assigned number of sequences" is the title of a paper read by Prof. F. Morley at the May meeting of the Society. In *Liouville's Journal* 1895, and in earlier memoirs, M. André proves the formula $P_{n,s} = s P_{n-1,s} + 2 P_{n-1,s-1} + (n-s) P_{n-1,s-2}$, where $P_{n,s}$ is the number of permutations of n things (say of the number 1, 2, . . . n) with s sequences; and shows that (taking the number of sequences as great as possible) the numbers $\frac{1}{2} P_{n+1,n}$ are the coefficients of $x^n/n!$ in $1/(1-\sin x)$, when expressed as a Maclaurin series. Prof. Morley states his object to be to obtain a function of x and y which, when developed in positive integer powers of x and y, will have $P_{n,s}$ as the general coefficient.—Dr. V. Snyder reviews "La Géométrie réglée et ses Applications," by G. Kœnigs. The reviewer remarks: "One gathers that the author had intended to make the treatise much more extensive, especially as the second part of the title is entirely ignored. Roughly the book is a reproduction, with some extensions, and some omissions, of parts of three papers by Prof. Klein (*Math. Ann.*, ii. pp. 203-213; v. pp. 257-268 and pp. 278-293). Should one use the book, to enable him to better understand most of the memoirs on line-geometry, it would prove a valuable aid, but read alone, the reader would get but a narrow and one-sided idea of its usefulness."—The courses of lectures at the University of Berlin, and other fragments of mathematical news are given in the Notes.

Symons's Monthly Meteorological Magazine, October.—Weather maps and early synchronous meteorological observations. On June 5, 1850, the Secretary of the Smithsonian Institution wrote to Mr. Glaisher to learn what was being done in this country. Mr. Glaisher's reply is printed, and, as Mr. Symons points out, the letter is very remarkable, considering its date, and shows that the first reports made at fifty railway stations about the year 1849 were not telegraphed but were sent by train. These were collected each afternoon in London by the *Daily News*, and thirteen of them were printed in their next issue. The observations were also collated and charted day by day by Mr. Glaisher. The first daily report issued by Admiral FitzRoy was on September 6, 1860.—True time. This is a reprint of a circular by Mr. John Milne, stating that there

is no publication which shows the corresponding value in Greenwich mean time of the local time employed throughout the world. Such a table is much wanted, and is indispensable in order to determine the instant of occurrence of earthquakes, magnetic phenomena, &c.—Sunless days and the day-distribution of sunshine in summer. This is a discussion of twenty years' observations at Greenwich (1877–96). About one-fourth of our days are sunless. Spring has an average of 12·1; summer, 6·4; autumn, 25·0; and winter, 48·5 sunless days. The most "bright sunshine" occurs in May. During the five months May to September, 20 per cent. of the days have less than one hour's sunshine, while 14 per cent. have ten hours, or more. There are only eight cases of fourteen to fifteen hours' sunshine, and only one (in 1887) over fifteen hours.—Other papers refer to "so-called sulphur rains," "trees damaged by lightning," &c.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 19.—Mr. J. Cosmo Melvill, President, in the chair.—The death of Mr. James Heywood, F.R.S., the father of the Society, was announced, and a vote of condolence with the family was moved.—Prof. H. B. Dixon described experiments made in photographing explosion-flames: first, attempts made abroad, and afterwards experiments of his own.—Prof. F. E. Weiss exhibited some flowering specimens of the Dog's Mercury, which usually flowers in spring; but the plant from which the shoots exhibited were collected has been observed by Mr. F. J. George, of Chorley, for thirteen successive seasons to flower in the autumn. Sir Joseph Hooker, to whom some of these shoots had been sent, was of the opinion that this plant might be regarded as a special form with this autumn flowering character.—A paper by Mr. P. Cameron, entitled "Notes on a collection of Hymenoptera from Greymouth, New Zealand, with descriptions of new species," was communicated by the President.—Mr. Melvill afterwards exhibited some specimens of *Sisymbrium strictissimum*, found by Mr. Henry Hyde on the banks of the Mersey at Stretford.

PARIS.

Academy of Sciences, October 18.—M. A. Chatin in the chair.—On the observation and kinematical interpretation of the phenomena discovered by Dr. Zeeman, by M. A. Cornu. The phenomenon in question, the formation of doublets and triplets in a spectrum by the action of external magnetic forces, is shown experimentally to be subject to the laws of Fresnel and Ampère. It differs essentially from the Faraday effect, in that the latter is produced upon luminous waves that have acquired a steady state, causing an alteration in the velocity of propagation, whilst in the Zeeman effect the magnetic action is exerted upon the source of the waves, and affects the period of vibration.—An account of the International Geological Congress at St. Petersburg, by M. Albert Gaudry.—On pencils and congruences, by M. Guichard.—Researches upon alcohol motors, by M. Max. Ringelmann. Two sets of trials were made, one upon a 3 h.p. horizontal, the other upon a 4 h.p. vertical oil engine. As the result of the trials it was found that the cost of alcohol, petroleum spirit, and ordinary burning oil were 5·625, 1·75 and 1·00 respectively.—On the form of the lines of electric force in the neighbourhood of a Hertz resonator, by M. Gutton. The field was explored by means of a modification of the receiver of Prof. J. C. Bose.—Densities of some easily liquefiable gases, by M. A. Leduc. The gases examined were carbon dioxide (1·5287), nitrous oxide (1·5301), hydrogen sulphide (1·1895), chlorine (2·491) and ammonia (0·5971).—On the impurities of crude copper, by M. Schlagdenhauffen. Thin sheets of crude Chilian copper, left in contact with water for several days, gave up appreciable quantities of arsenious acid and oxide of antimony. From this experiment the conclusion is drawn that arsenic and antimony are present, at any rate in part, in the form of oxide in crude copper.—On the electric conductivity of trichloracetic acid, by M. Paul Rivals. Measurements of the conductivity and heat of solution of trichloracetic acid at different concentrations showed that the heat of dilution of this acid is a linear function of the fraction of dissociation. The heat of neutralisation by potash (N) calculated from Ostwald's formula, $N = 13{\cdot}52 + (1 - m)d$, where 13·52 is a constant common to both strong acids and strong bases, m is the fraction of dissociation, and d the heat of dissociation, accorded very closely with the experimentally determined values.—On the mean molecular weight of the soluble material in germinating grains, by M. L. Maquenne.—General observations on oats, by M. Balland. An analytical table is given, showing the maximum and minimum values of the proximate constituents of oats.—New bile pigments, by MM. A. Dastre and N. Floresco.—Action of the X-rays on the heat radiated by the skin, by M. L Lecercle. Under the action of the X-rays there is an increase in the radiation of heat from the skin, an increase which frequently persists for some time after the exposure.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Founders of Geology: Sir A. Geikie (Macmillan).—Papers printed to commemorate the Incorporation of the University College of Sheffield: The Winter Meteorology of Egypt, and its Influence on Disease: Dr. H. E. L. Canney (Baillière).—Chemistry for Photographers: C. F. Townsend (Dawbarn).—Memorials of Wm. Cranch Bond and of his Son Geo. Phillips Bond: E. S. Holden (San Francisco, Murdock).—Life-Histories of American Insects: Prof. C. M. Weed (Macmillan).—Tracé d'un Chemin de Fer: A. Dufour (Paris Gauthier-Villars).—Theoretical Mechanics: A. E H. Love (Cambridge University Press).—A Practical Physiology: Dr. A. F. Blaisdell (Boston, Ginn).—Ostwald's Klassiker der Exakten Wissenschaften, Nrs. 88–91 (Leipzig, Engelmann).—Nights with an Old Gunner: C. J. Cornish (Seeley).—Report of the Commissioner of Education for the Year 1895–96, Vol. 1, Part 1 (Washington).—La Vie Mode de Mouvement: Prof. E. Préaubert (Paris, Alcan).—Wechselstrommessungen und Magnetische Messungen: Dr. C. Heinke (Leipzig. Hirzel).—Notes on Micro-Organisms Pathogenic to Man: Surgeon-Captain B. H. S. Leumann (Longmans).

PAMPHLETS.—Revision of the Tachinidæ of America North of Mexico: D W. Coquillett (Washington).—Zur Psychologie des Erkennens: Dr. G. Wolff (Leipzig, Engelmann).

SERIALS.—Physical Review, August (Macmillan).—Bibliotheca Geographica herausgegeben von der Gesellschaft für Erdkunde zu Berlin, Band iii. Jahrg. 1894 (Berlin).—Revue de l'Université de Bruxelles, October (Bruxelles).—Bulletin of the American Mathematical Society, October (New York).—Traité Encyclopédique de Photographie: Prof. C. Fabre, deux supplément, B, 1. 2, 3 fasc. (Paris, Gauthier-Villars).—Journal of the Chemical Society, October (Gurney).—Quarterly Review, October (Murray).—Middlesex Hospital Journal, No. 4 (London).—Reliquary and Illustrated Archæologist, new series, Vol. 3 (Bemrose).—Longman's Magazine, November (Longmans).

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